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MEMOIRS.

NOTES *of a* COURSE *of* PRACTICAL HISTOLOGY *for* MEDICAL STUDENTS. Given in King's College, London, by WM. RUTHERFORD, M.D., F.R.S.E., Professor of Physiology.

AT the present time there is much discussion regarding the manner in which Practical Physiology should be taught to medical students. Perceiving the difficulties which physiological teachers have to encounter in carrying out the new regulations of the College of Surgeons, the Editor of this Journal has asked me to give a *résumé* of my course of Practical Histology. I do not regard my course as perfect, nevertheless I have found it work successfully through several years, and, after having ascertained the modes of tuition adopted elsewhere in this country and in Germany, I have come to the conclusion that on no other system does the student accomplish so much in so short a time.

The system of teaching is essentially that adopted by my old master, Professor Bennett, of Edinburgh, the gentleman who first taught Practical Histology in this country. Under Professor Bennett's direction I taught the subject in a manner differing somewhat from that which I now adopt. In Edinburgh, the students of my ordinary class merely examined the tissues. I now find no difficulty in providing every pupil with the means for making for himself a little cabinet of microscopic specimens of the various tissues. This involves little trouble, and greatly increases the interest with which the student follows the class.

It is not advisable to teach more than five-and-twenty or, at the outside, thirty students at a time. To teach even this number satisfactorily requires three skilled assistants—senior students who have been through the course, and can assist the uninitiated. The whole of Histology may be gone through in twenty-four lessons, each lesson lasting from an hour and a half to two hours. The tuition of this class is more laborious than that of any other with which I am acquainted: the chief cause of the labour is the manipulation of the micro-

scope. If the microscope be one that is thoroughly satisfactory, such as Hartnack's, the labour of tuition is light; but if it is one of those clumsy machines so commonly met with in this country the labour is fearful.

The microscope which, in my opinion, is by far the best, both for the student and any one who wants really to work, is that made by Hartnack. It is so easy to work with it. The stage is just high enough to permit of the hand moving the slide without the arm being raised from the table. That expensive and time-wasting apparatus, the moveable stage, is absent. I generally recommend this apparatus for persons who cannot learn how to properly regulate the movements of their fingers. The coarse adjustment is effected by sliding the tube up or down without the use of a rack and pinion—another expensive and useless addition. Some persons say, that without the rack and pinion the student will bring the lens down on the cover-glass, and break the preparation or, it may be, the lens. After having given twenty-six courses of Histology, and after having taught some five hundred students, I am glad to say that I never had a lens injured, and I have only had two covering glasses of preparations broken in this way. The student only requires to be carefully instructed on this point when he begins to work with the microscope. Hartnack's lenses, too, are so excellent, that the student can easily see things clearly, and not in a mist, as is the case with most English cheap lenses, and with the majority of Gundlach's 1-8th, which find their way to this country. In the matter of microscopes tastes vary much, of course; but, for my part, I can say, that while I have found it satisfactory and comparatively easy to teach a class with Hartnack's microscope, I have found it terrible labour to do so with the ordinary educational microscope of these realms, with its great long tube, always needing the pillar to be bent, or compelling one to stand in order to look through it when it is vertical, its stage far too high, &c. I therefore think, that the first great essential for the successful tuition of Histology is to place the student in possession of a thoroughly good microscope on Hartnack's model. Such microscopes are made by Mr. Crouch, but his lenses, though superior to the general run of Gundlach's 1-8th's, are not quite equal to Hartnack's.

Some teachers give the student a programme of what he is to do at each lesson, and let him proceed to work upon it independent of the other students. The argument urged in favour of this plan is, that the good are not held back by the

stupid students, but are free to go on with the programme, and to execute it as rapidly as they like.

This plan is good when you have not more than half a dozen pupils and plenty of time to teach them. It involves your repeating to every student the remarks you may have to make. In my opinion, the plan is an utter failure if your time is limited, and the number of your students more than six or so. I have tried it with the number fourteen, and the best part of a day to teach them not a very long lesson. Nothing would tempt me to try it again in the tuition of an ordinary class. The plan I now adopt on all occasions is to treat my class like a regiment of soldiers, making every one do the same thing at the same time. The interest is thoroughly kept up by making the class a sort of debating society. While every one looks at the same object, I ask one student after another to describe what he sees. The observations of one student are in this way checked by the observations of another. The class resembles a little army of investigators—it is, in fact, a miniature of the histological world. The power that every student has of criticising the observations of his fellows makes, as might be supposed, every one exceedingly careful. A simple object like yeast is taken first. I give no description of the torula, but I ask the student to describe and then to draw what he sees. Any one may be called upon to do this. Any one who disagrees with any statement is asked to do so, and to give a demonstration in support of his opinion. To facilitate such descriptions every student has a card on which are printed the following points:—1. Shape. 2. Edge. 3. Colour. 4. Transparency. 5. Contents. 6. Size. 7. Effects of reagents. The card prevents the student from getting bewildered, and teaches him method and thoroughness. Care is taken that no one ever becomes idle. If his preparation is made, and he be waiting on his neighbours, he occupies his time in drawing. When we come to complex structures, such as bone, I give a brief preliminary account of the subject, in order that every one may understand what he sees. By questioning the student as the demonstration goes on, it is easily ascertained whether he understands what he is about. On all occasions, however, I endeavour to make the student describe what he sees. This method really *educates* him in a way such as no other method, in my opinion, can. When necessary I show preparations which have been previously made. With a subject like teeth this is, of course, necessary, but whenever it is possible each student makes his own preparations, and preserves them when they are worth keeping.

Every student provides himself with a box of slides and cover-glasses, scissors, forceps, scalpels, razor, mounting clips, needles in handles, camel-hair pencils, while he is furnished with all the tissues, reagents, &c. I give every student a stand with twelve one-ounce bottles, containing the reagents. The bottles have good corks, in which are fixed glass rods, sable, or camel-hair pencils. Some may say that corks are bad in such a case. If expense were no object, of course one would use Beale's excellent drop bottles, but they are too expensive for class purposes, and really the corked bottles do very well. I very rarely find a single cork cell in any preparation. The fluids contained in the bottles are—

1. Distilled water, so that a drop of clean water may be had when necessary. 2. Solution of chloride of sodium 0·75 per cent. (7.5 grains dissolved in 1000 grains of water), for treating delicate protoplasmic tissues. This is commonly called salt solution. 3. Absolute alcohol. 4. Oil of cloves. 5. Oil of turpentine. 6. Glycerine. 7. Acetic acid. 8. Weak spirit (1 part methylated spirit, 3 parts distilled water). 9. Solution of magenta for staining protoplasm. (See staining of tissues.) 10. Saturated solution of potassium acetate for preserving osmic acid preparations. 11. Solution of Canada balsam in turpentine.[1] (Pure Canada balsam, dried till it is hard and crystalline, and then dissolved in turpentine.) 12. A thick solution of Dammar resin in benzole, as a luting. (This dries rapidly enough, does not crack, does not "run in" like that sepulchral abomination asphalt.) Other reagents are only occasionally used, and are provided when required.

At the beginning of the course a general account is given of the microscope and accessory apparatus. The student is instructed how to clean the instrument, how to measure its magnifying power, how to measure the size of an object, and how to draw. After this every student is provided with his microscope, and the regular work of demonstration begins. From time to time, as the course advances, short accounts are given of the preparation and preservation of objects, &c. These are not entered into, however, until the student has had a little experience of the effect of agents upon torulæ, blood-corpuscles, &c.

[1] I have hitherto always employed this fluid for class purposes. In future I mean to use Dammar solution instead of it. See "How to Preserve Tissues."

Preparation of Tissues previous to Commencement of the Course.

A month before the course begins it is necessary to prepare some tissues—*e.g.*, to soften bone, to harden nerve tissues, &c. A cat is a convenient animal to take. Kill it by bleeding during digestion; inject 0·75 per cent. solution of common salt in water into the pulmonary artery, aorta, and portal vein; open the stomach, and wash out the interior with the salt solution; inject the salt solution into the intestine in order to wash out the chyme and fæces; cut intestine into short pieces; place it, half of the stomach, half of the liver, the spleen, the lungs, in a jar containing a large quantity of ¼ per cent. solution of chromic acid; place the other half of the stomach and liver in methylated spirit; take out brain and spinal cord, and place them in methylated spirit (see "Demonstration of Nerve Tissue"); pierce the sclerotic with holes, and put the eyes into Müller's fluid. (See "How to Harden Tissues.") Place the bones in the fluid recommended for softening bone. (See "How to Soften Tissues.") When all those tissues are hard enough, and when the bone is soft enough, place them in methylated spirit until sections are to be made.

Demonstration of Tissues prepared by Each Student.

The following is the order and the nature of the work undertaken by my students. There is no difficulty in their executing it in the number of lessons above mentioned. To avoid repetition, let it be understood that mensuration and drawing are practised whenever it is possible.

1. *Germinating yeast.*[1]
   D 1.[2] Examine different forms of the torulæ. *a*, Add magenta; observe effects. *b*, Rupture the torulæ.
2. *Penicillium.*[3]
   D 1. Submerged hyphæ. *a*, Add magenta. *b*, Rupture.

[1] The idea of beginning with this I owe to my friend Professor Huxley.
[2] D 1 means Demonstration 1.
[3] The germs of common mould must be sown a week or so beforehand in the following fluid, a modification of Pasteur's fluid:

Water	83·76 parts
Cane Sugar	15·0 "
Ammonium Tartrate	1·0 "
Potassic Phosphate	0·2 "
Calcic Phosphate	0·02 "
Magnesium Sulphate	0·02 "

D 2. Aerial hyphæ. *a*, Add magenta; observe hyphæ, gonidia.

3. *Hairs from stamens of Tradescantia virginica.* Hairs in water; observe the cells, wall, nucleus, protoplasm, vacuoles, and movements of the protoplasm. *a*, Heat, and observe effect. *b*, A hot stage suitable for roughly heating a microscopic object may be made of a plate of tin, 9 × 2½ inches, with a small hole in the centre. The slide is laid upon it and a spirit lamp is applied at the end of the plate. For fine work, of course, Stricker's hot stage is necessary.

4. *Vallisneria.* Portion of leaf, to see cyclosis. Heat, if the movement be sluggish.

5. *Nettle hair.* Examine protoplasmic movements.

6. *Potato.* Thin section; examine starch. *a*, Add solution of iodine.

7. *Cotton fibres.* Add iodine and sulphuric acid.

8. *Linen fibres.*

9. *Section of cork.*

10. *Disc-bearing tissue.* Thin vertical section of cedar pencil.

11. *Dust* from some shelf.

12. *Gamboge*, rubbed up in water for Brownian movement.

13. *Bacteria*, from infusion of muscular fibres.

D 1. Examine movements, &c. *b*, Add magenta.

D 2. *a*, Examine movements. *b*, Heat slide to boiling point. *c*, Examine the fluid again.

D 3. Another specimen; add a solution of quinine.

14. *Infusoria.* From old water of flowers, or infusion of muscle. Add iodine or magenta solution.

15. *Amœba.*

16. *Blood of newt.* White blood-corpuscles. Watch movements; heat if necessary.

17. *Cilia.*

D 1. Epithelium from trachea of a cat newly killed by bleeding. Examine in salt solution. Observe mucus-corpuscles, &c.

D 2. Cilia from gill of salt-water mussel. Examine in sea water. *a*, Apply heat.

D 3. Mussel cilia, expose to vapour of chloroform. Place cilia on under surface of a cover glass, forming the roof of a putty cell, on the floor of which a drop of chloroform has been placed.

18. *Cylindrical epithelium* from intestine of the same cat.

Snip off villi. Examine in salt solution. Cylinder and goblet cells. Add magenta.

19. *Glandular epithelium.* Gastric follicles of the same cat examined in salt solution.

20. *Squamous epithelium.* Human saliva. *a,* Examine epithelium and salivary cells. *b,* Add magenta. Observe coloured nuclei and fibrils of coagulated ptyaline.

21. *Frog's blood.*

D 1. Examine corpuscles. *a,* Add water to one side of drop. *b,* Add acetic acid to the other side. Observe effects.

D 2. Same blood. Add syrup or saturated solution of NaCl.

D 3. Same blood. Add magenta fluid, that especially used for staining blood. (See staining of tissues.)

D 4. Same blood. Add solution of tannic acid. (Two grains dissolved in one ounce of warm water, and allowed to cool.) Then add ordinary magenta fluid. (See staining of tissues.)

22. *Bird's blood.* Add magenta.

23. *Blood of fish.*

24. *Human blood.*

D 1. Examine corpuscles. Add water at one side of glass and acetic acid at the other.

D 2. Same blood. Add magenta. (Special fluid for staining blood—see staining of tissues.)

D 3. Same blood. Add tannic acid solution, and, after a time, ordinary magenta fluid.

25. *Blood of crab.*

26. *Blood of guinea pig* for hæmoglobin crystals.

27. *Pus.* Examine, and then add acetic acid.

28. *Mucus.* Examine, and add acetic acid.

29. *Elastic tissue.* Lig. nuchæ of ox.

Examine. *a,* Add acetic acid, alcohol, and preserve.

30. *Areolar tissue.* Omentum from cat just killed.

D 1. Examine in salt solution. *a,* Add magenta.

D 2. Preserve in weak spirit.

31. *Adipose tissue,* from omentum of the same cat.

D 1. In salt solution, preserve in glycerine.

D 2. Adipose tissue which has been previously carminised so as to stain the nuclei of the fat-cells. (Magenta does not stain these readily.) Preserve in glycerine, to which hydrochloric acid has been added. (See "How to Preserve Tissues.")

32. *Subcutaneous areolar tissue* from the same cat.

D 1. *a,* Gently spread it out on dry glass, then add

salt solution and examine. *b*, Take off cover glass and tear to pieces, in order to split up white fibres. *c*, Add acetic acid.

D 2. A new preparation for preservation in weak spirit.

D 3. A new preparation for preservation in glycerine.

33. *Tendon.*

D 1. Transverse section of slightly dried tendon.

D 2. Vertical section of the same. Preserve in weak spirit.

34. *Cartilage.*

D 1. White fibro-cartilage from intervertebral disc, in salt solution. Add magenta.[1] Preserve in the following mixture: glycerine 1 part, water 2 parts.

D 2. Yellow fibro-cartilage from epiglottis. Preserve in the above dilute glycerine.

D 3. Hyaline cartilage. Section parallel with and near to the articular surface of articular cartilage. Preserve in dilute glycerine.

D 4. Vertical section of articular cartilage on head of a bone which has been softened. Preserve in dilute glycerine.

D 5. Section of costal cartilage of an old person. Preserve as above.

All these forms of cartilage may be previously macerated in methylated spirit, and the sections mounted in Canada balsam. (See "How to Preserve Tissues.")

35. *Bone.* T. S.[2] and L. S. long bone of a cat previously softened and preserved in methylated spirit. Mount in methylated spirit. Return to the sections of costal and articular cartilage, and examine them in this connection.

36. *Tooth.* Show how sections of hard bone and tooth are made. Send round a series of preparations of teeth and different kinds of bone.[3]

37. *Muscle.*

D 1. Boiled mutton or muscle of rabbit or cat. (The muscle must be fresh before being boiled.)

D 2. Boiled fish.

[1] Magenta fades. Carmine must be used for things that are to be permanent.

[2] T. S. means transverse section; V. S., vertical section; L. S., longitudinal section.

[3] Such a series is previously arranged in order; those for a low and those for a high power are placed in different groups. Every preparation has a label mentioning all the points to be observed. When for a low power it is marked L.; if for a high power it is marked H. The preparations are given to the students in order. They are questioned regarding them, and when sufficient time has been allowed for the examination of each, a bell is rung, and every man passes his preparation on to his neighbour.

D 3. Boiled crab.
Preserve all these in glycerine, glycerine jelly, or weak spirit.

D. 4. Fresh muscle of frog. Dissect it with needles in water, in order to see sarcolemma. Add acetic acid.

D 5. Muscle of frog previously carminised. Preserve in acid glycerine.

D 6. Muscle of frog or cat, which has been macerated in dilute nitric acid (1 of acid to 4 water) for a week or so. Squeeze fibres in order to get fibrils and discs. Preserve in spirit or glycerine jelly.

D 7. Fresh muscle from leg of water beetle in salt solution, to see contraction waves, fibrils, and nerve endings.

D 8. Non-striped muscle from boiled stomach. Preserve in spirit or glycerine jelly.

D 9. Give each student a small piece of carminised frog's bladder. Preserve in acid glycerine.

38. *Blood-vessels.* Brain of a sheep cut into small pieces and macerated for two days in glycerine.

D 1. Strip off pia mater. Wash in water with the aid of a camel-hair pencil. Add acetic acid. Preserve in glycerine.

D 2. A new preparation. Add no acid. Preserve in glycerine jelly.

D 3. Stain blood-vessels of frog's mesentery with nitrate of silver (see staining of tissues), and examine it next day. Preserve in glycerine jelly.

D 4. Aorta of ox. T. S. with Valentin's knife. Preserve in glycerine jelly.

Show how to inject, and send round a series of preparations showing injected areolar tissue, bone, tooth, muscle, and various arrangements of blood-vessels.

39. *Nerve.*

D 1. Fresh nerve of frog. *a*, tease out with needles in salt solution, and examine. *b*, Wash with water and tease the nerve out in the water, and examine again to see the fibrillation of the white substance.

D 2. L. S. white matter of fresh spinal cord of sheep. (Add no fluid.)

D 3. White matter of fresh cerebrum of sheep. (Add no fluid.)

D 4. Cells of fresh Gasserian ganglion in salt solution. Add magenta to colour cells and axial cylinders.

D 5. Grey matter of cerebellum (fresh) to see cells of inner grey layer. (Add no fluid.)

Describe how to harden, cut, and preserve nerve tissue. 1st. Cut perfectly fresh nerve tissue into pieces, not larger than a walnut if possible, and (2nd) place them for twenty-four hours in methylated spirit. 3rd. Place them for a week in the following fluid: 1 part chromic acid, 2 parts potassium bichrom., 1200 parts water. 4th. Place them in a fluid twice this strength for four or six weeks. 5th. Make sections, wet the knife with water or methylated spirit (if the latter, the spirit must be afterwards thoroughly washed from the sections with water). 6th. Place the sections for at least half an hour in 1 part potass. bichrom., 200 parts water. 7th. Wash in water frequently changed. 8th. Colour with carmine, 10 parts carmine, 500 parts of strongest ammonia, 100 parts glycerine. Gradually mix the ammonia with the carmine in a mortar, and then add the glycerine. Lay the sections in this fluid for a period varying from one to 48 hours. 8th. Place them at once in methylated spirit, or wash them with distilled water to remove superfluous pigment. Then place them in methylated spirit for at least twenty-four hours; they will then be ready for mounting. 9th. Place a section on a slide, wash it with absolute alcohol, or better, put it in a watch glass containing absolute alcohol for a few minutes, and then lay it on the slide. Wait until it dries somewhat (until it becomes sodden), then, 10th. Clarify it with turpentine or clove oil. Insinuate a drop of either oil under the section by means of a *sable* hair pencil. When it *has driven all the spirit into the air* put a drop on the upper surface. 11th. When sufficiently clear put on a drop of Dammar or Canada balsam solution, and then put on the covering glass.

D. 6. Uncoloured T. S. hardened spinal cord of cat.

D 7. Carminised section of the same.

D 8. Carminised V. S. of the same.

D 9. V. S. cerebellum of cat carminised.

D 10. V. S. Cerebrum of cat carminised. Render this one very transparent with clove oil.

D 11. V. S. cerebrum of cat carminised. Render this only semi-transparent.

The sections D 6 to D 11 are rendered transparent with oil of cloves or oil of turpentine, and are mounted in Dammar or Canada balsam.

40. *Lung*. Fresh lung of cat.

D 1. Thin section with scissors. Add salt solution. Press in order to expel air. Add acetic acid.

D 2. Section of hardened lung kept in methylated spirit. Mount in glycerine.

D 3. Examine a series of lung preparations.

41. *Alimentary canal.*

D 1. T. S. hardened cat's tongue.

D 2. V. S. hardened stomach.

D 3. V. S. hardened small intestine of cat.

Clarify and preserve D 1, 2, and 3 with glycerine.

D 4. Fresh small intestine of cat, killed during digestion. Wash surface of mucous membrane with salt solution. Snip off a few villi with scissors and examine them.

D 5. T. S. hardened large intestine of cat. (Treat as in D 3.)

Examine a series of preparations of alimentary canal.

42. *Liver.*

D 1. Cells of fresh cat or rabbit's liver. Examined in salt solution. Add magenta.

D 2. Cells of liver of ox, examined in the same way. These are usually fatty.

D 3. Thin section of liver of cat hardened in chromic acid or alcohol. Clarify with, and preserve in, glycerine.

Examine a series of preparations of injected liver, salivary glands, and pancreas.

43. *Kidney.*

D 1. V. S. with Valentin's knife Malpighian pyramid of fresh sheep's kidney, examined in salt solution. *a*, Examine with low power. *b*, Take off covering glass and dissect with needles a portion of the cortical and a portion of the medullary substance. *c*, Examine with high power. *d*, It may be necessays to wash the section with salt solution; use a camel-hair pencil for this purpose. *e*, Add magenta, and observe the action upon the epithelium of both straight and convoluted tubules, and the effect upon the matrix.

D 2. T. S. of frozen Malpighian pyramid near its apex. (This may also be made from a fresh kidney with Valentin's knife.)

D 3. Scrape the cut surface of the cortical substance, in order to get isolated Malpighian bodies. Add acetic acid.

D 4. Give each student a thin vertical section of the Malpighian pyramid of a pig's kidney, which has been macerated for eight days in $\frac{1}{5}$ per cent. solution of potassium bichromate, and washed in water for fifteen minutes (Klein). Mount in glycerine.

Examine preparations of injected kidney.

44. *Spleen.* Give every student a piece of fresh spleen of ox and a portion of hardened spleen of cat. *a,* Examine cut surface of fresh spleen to see pulp and splenic corpuscles. *b,* Draw out an artery, in order to see the corpuscles better. *c,* Scrape the pulp away, in order to see the trabeculæ.

D 1. Section of hardened spleen. *a,* Examine in glycerine. *b,* Remove the covering glass, and pencil the section with a camel-hair brush in order to remove blood-corpuscles and see adenoid tissue. Mount in glycerine.

45. *Lymphatic glands.*

D 1. Section of gland hardened in alcohol. *a,* Examine in glycerine. *b,* Pencil the section in order to see adenoid tissue. Mount in glycerine.

D 2. Chyle from thoracic duct.

Examine preparations of blood glands.

46. *Skin and epidermic appendages.*

D 1. V. S. skin of human finger hardened in chromic acid. Examine, and preserve in glycerine.

D 2. V. S. skin of cat hardened in chromic acid for hair follicles, and erector muscle. Preserve in glycerine.

D 3. V. S. fresh skin from back of sheep's head to see sebaceous glands. Add acetic acid.

D 4. Human hair.

D 5. Hair of sheep.

D 6. Hair of rabbit.

Show how to make transverse sections of hair imbedded in gum. (See How to make sections of tissues.)

D 7. T. S. nail.

D 8. Scales of moth or butterfly. Mount preparations 3 to 7 in Dammar or Canada balsam.

Examine preparations of injected and carminised skin, Wagner's and Pacini's corpuscles, and various kinds of hair, hoof, horn, feather.

47. *Eye.*

D 1. Section of lens of ox boiled for five to ten minutes in dilute sulphuric acid 1 per cent. in order to see fibres. Dissect with needles. Examine, and preserve in glycerine.

D 2. Section across fibres of lens of ox hardened in spirit for three days.

D 3. V. S. cornea of cat hardened in chromic acid. Mount in glycerine.

D 4. V. S. Retina of pig or calf prepared by Klein's method. 1st. Take perfectly fresh eye, and pierce sclerotic and cornea with a needle in several places. 2nd. Place it in Müller's fluid (see hardening fluids) for three weeks. 3rd. Cut the eye transversely into two portions. 4th. Take the retina out, and place it in dilute alcohol for three to five days. 5th. Place in dilute ammoniacal solution of carmine for twenty-four hours. 6th. Wash in water and place in absolute alcohol for half to one hour. 7th. Place in oil of cloves until transparent. 8th. Place it between two plates of wax and oil (equal parts) or paraffin, and make sections. 9th. Mount in Dammar.

D 6. Choroid hexagonal pigment cells.

D 7. Fibrous tissue of choroid to see branched pigment cells. Mount 6 and 7 in glycerine.

Examine a series of preparations of injected choroid, ciliary processes, retina, ciliary muscle, iris, vitreous humour, &c.

47. *Generative organs and development.* Examine preparations of ovary, uterus, testis, prostate, penis, and the embryo at various stages of development.

General Considerations.

Examination of Tissues.—Tissues should always be examined in as fresh a state as possible. At death, the optical characters of many tissues undergo rapid change. Generally transparency diminishes.

Some tissues, such as bone, tooth, and hair, may be examined in air. This is generally objectionable; the shadows are too dark.

Some fluids alter the appearances presented by the tissues. *e. g.*, water causes the blood-corpuscles to swell, syrup shrivels them up.

In selecting a medium in which to place the tissue, we must take into consideration the physico-chemical nature of the tissue and the medium. The most important points are, 1. The density of the tissue and the medium. 2. The solubility of the tissue in the medium. 3. The degree of transparency possessed by the tissue. 4. The refractive index of the medium. 5. The chemical relations between the tissue and the medium.

In order to see the normal characters of fresh tissues, examine in the fluids which bathe them, or in such fluids as will not alter them. Blood, salivary, and pus-corpuscles are

examined in their own fluids. The fluid which bathes most tissues is lymph. Blood serum, aqueous humour, amniotic fluid, dilute egg albumen, may be substituted for it. Saliva may also be used for fresh tissues. The objections to saliva and blood serum are the corpuscles which they contain. The serous fluids may be preserved for many weeks by putting them with a lump of camphor into glass vessels which have been washed with *boiling* water. Iodised serum is often employed. The iodine tends to preserve the serum from decomposition, and tinges tissues slightly. Six drops of tincture of iodine to 1 oz. of fresh amniotic or other serous fluid. Failing serous fluids the most widely useful fluid is salt solution, 0·75 per cent. in water (7·5 parts of dried chloride of sodium in 1000 parts of water). Water may be used as a medium for elastic tissue, hair, and epidermis and similar tissues, but it destroys most soft tissues.

How to alter the Density of Tissues.—Some tissues are too soft, others too hard to permit of their being cut or dissected, it is therefore necessary to alter their density.

A. *How to harden Tissues.*—1. Drying, generally bad, may be used for tendon, ligament, and skin. 2. Freezing. Useful for hardening a fresh tissue, such as muscle, lung, liver, spleen, lymphatic glands, kidney; not well adapted for nerve tissue. (See a description of my method of freezing and cutting frozen tissues in 'Journal of Anatomy and Physiology,' May, 1871, page 324.) 3. Boiling may be used for crystalline lens and muscular fibres. 4. Alcohol, suitable for gland tissues; *e. g.*, stomach, liver, salivary glands, and pancreas. Use first dilute then absolute alcohol. 5. Chromic acid. The hardening agent most widely employed; 0·25 per cent. watery solution for most tissues, such as alimentary canal, cornea, and skin. For lung, inject the chromic acid solution into the pulmonary and the bronchial artery of fresh lung of cat. Cut the lung into small pieces, and lay it in this fluid for a week. For liver, inject into portal vein ¼ per cent. solution of chromic acid. For brain and spinal cord, see the directions given under the demonstration of these tissues. Chromic acid hardens the tissues in from one to six weeks. Sections of tissue hardened in alcohol or chromic acid require to be rendered transparent with glycerine, turpentine, or clove oil; they may be mounted in glycerine, Dammar, or Canada balsam. 6. Müller's fluid (2½ parts potassium bichromate, 1 part sodium sulphate, 100 parts distilled water) used for the retina and eye generally, also for macerating areolar tissue; requires from three to six weeks. 7. Osmic acid, 1-10th to 1-5th per cent. in distilled water, for

hardening the retina and epithelium, hardens the tissue in a day or two; when hardened, place in distilled water for a few days. Mount in saturated solution of potassium acetate.

B. *How to Soften Tissues.*—Bone and tooth may be softened in 2 parts nitric acid, 1 part chromic acid, 100 parts water. A large quantity of this fluid always necessary. It is sometimes desirable to soften or dissolve various connective substances, such as white fibrous tissue, the cement which connects the fibres of the lens and the fibrils of striped muscle. White fibrous tissues may be softened in boiling water. This is useful for coarse dissections of muscle. 2nd. By maceration, at a temperature of 116° Fah., in dilute sulphuric acid (1-10th per cent.). 3rd. By maceration in glycerine (1 oz.), and glacial acetic acid (5 drops), (Beale). This is invaluable for enabling us to trace the endings of nerves in many tissues. (See Beale, 'How to Work with the Microscope.') The cement between the fibrils of the nerve axial cylinder may be dissolved by 1st, maceration in the above acid glycerine (Beale). 2nd, by maceration in iodised serum (Schultze). The cement joining the fibrils of striated muscle may be dissolved by maceration in dilute nitric acid (1 acid, 4 water). The cement connecting the fibres of the lens may be dissolved by boiling for five or ten minutes in dilute sulphuric acid (1 per cent.).

Separation of Tissue Elements.—1. By dissection with needles in handles. 2. By pressure. The separation is facilitated by the above-mentioned processes for softening and dissolving connecting substances.

How to Make Sections of Tissues.—Some tissues are too soft, others are too hard, to permit of sections being readily made. Harden or soften in the above-mentioned ways. Sections of softened bones and teeth made with a fine circular or straight saw. The sections are then ground sufficiently thin upon a hone. Valentin's knife and scissors useful for cutting soft tissues, such as liver, lung, and kidney. Cartilage, or any tissue which by softening or by hardening has been brought to a density somewhat resembling it, is cut most readily by means of a scalpel or a razor. Cutting instruments must always be wetted. 1. Water. 2. Salt solution. 3. Methylated spirit. 4. Absolute alcohol are used for this purpose. 3 and 4 are the best, but they are only to be used in cases where spirit may be added to the tissue without altering it—*e.g.*, when the tissue has been hardened in spirit or chromic acid. The piece of tissue is often so small that it is impossible to hold it in the hand, and it is sometimes so brittle that it is apt to go to pieces when cut. To

overcome these difficulties it is necessary to imbed the tissue so as to support and hold it firm during the section. A convenient substance wherein to imbed tissues is carrot. Skin, blood-vessels and many other tissues may be readily cut after they have been placed between two slices of carrot; for hardened tendon, spinal cord, or liver, it is necessary to scrape hole in the carrot, and place the tissue therein. Where the shape of the tissue is very irregular, or its structure very delicate, carrot is not suitable; then the tissue should be imbedded in the following paraffine mixture: Solid paraffine, 5 parts; spermaceti, 2 parts; axunge, 1 part (Ferrier); or in a mixture of beeswax and olive oil (equal parts). These substances should be melted at as low a temperature as possible, and poured round the tissue, or for flat portions of tissue—*e.g.*, the retina, flat plates of them may be used, and the tissue laid between them. If the tissue be small, an *irregular* hole may be scooped in the end of a carrot, the tissue placed in it, and the paraffine mixture or the wax and oil poured round it. The carrot forms an excellent table for the knife to rest and move upon. Tissues to be imbedded in wax or paraffine should be as dry as possible, else the supporting substance will not cling to the tissue. The water may be removed from the surface of the tissue by immersing it for a short time in spirit, and then allowing it to dry. Very delicate tissues, such as the softened cochlea, may be imbedded in a strong solution of gum (Stricker). 1. Steep the tissue in absolute alcohol for twenty-four hours. 2. Make a cone of blotting paper. 3. Put into it a saturated solution of gum. 4. Place the tissue in the gum. 5. Set the cone in absolute alcohol to remove the water. 6. Dry it till it is hard enough. 7. Imbed it in paraffine or in carrot, and make sections. In making sections it is difficult to hold the tissue and the knife steady. This difficulty is overcome by using a machine. Such a machine, long used by botanists, has been improved by Mr. Stirling, sub-curator of the Anatomical Museum, Edinburgh, and by the author. (See 'Journ. of Anatomy and Physiology,' May, 1871.) The machine consists of a brass plate or table, having a hole in the centre. The hole communicates with a tube, at the bottom of which is a screw. The tissue is placed in the tube, and the paraffine mixture is poured around it; or the tissue is imbedded in a cylinder of carrot, previously cut to the size of the tube by means of a cork-cutter. The imbedded tissue is elevated by the screw, a razor is placed on the brass plate, and pushed by the hand obliquely through the tissue projecting from the hole. The screw is graduated,

so that a section of any thickness can be obtained. The instrument is also adapted for freezing tissues. All fine sections must *float* over the knife's surface, therefore the knife must be wetted. (See above.) The sections must always be manipulated with sable or camel's-hair brushes.

How to render Tissues Transparent.—A. By impregnating them with fluids which strongly refract light, *e. g.* glycerine, turpentine, clove oil, Canada balsam, dammar. B. By partially or completely dissolving certain elements of the tissues, so as to permit of others being seen—acetic acid, caustic soda, or potash. These partially or completely dissolve the soft albuminous parts of most tissues. 1. Price's glycerine is that which is used. 2. Glycerine and glacial acetic acid may be used together. G. 1 oz., acid 5 drops. (Beale.) 3. The acetic acid commonly used is ordinary pyroligneous acid. 4. The solution of soda is caustic soda 1 part, water 20 to 30 parts. These four fluids all mix with water, hence they are employed to clarify tissues from which water has not been removed. 5. Turpentine, clove or other essential oil, creosote, render most tissues transparent. They do not mix with water; therefore water must be previously removed by drying the tissue or by immersion in alcohol.

Tissues hardened in alcohol or chromic acid are rendered opaque, and must in general be clarified. This is generally done by adding, *a*, clove oil; *b*, turpentine; *c*, glycerine. These fluids have different powers—*a* is stronger than *b*, and *b* is stronger than *c*. Glycerine is employed for tissues that must not be made too transparent, *e.g.* spleen, alimentary canal, lung, liver. When it is used, the tissue is preserved in it. When clove or turpentine oil are employed, the tissue is preserved in Dammar or Canada balsam.

How to diminish the Transparency of Tissues.—Place them in alcohol, chromic acid, or stain them with the following substances:

How to Stain Tissues.—Attend to these points. The staining fluid may affect some parts of the tissue more than others, or it may affect some parts and others not at all. In this way it differentiates one part from another—*e. g.* the nucleus more affected by carmine or magenta than the surrounding plasm. The staining fluid may affect the tissue uniformly, and prove serviceable by merely rendering very transparent colourless parts more evident—*e.g.* elastic lamina of cornea stained by carmine. 1. Carmine, two fluids necessary. *a*, Strong ammoniacal solution for hardened nerve tissue. (See preparation of nerve tissue, *antea.*) *b*, Beale's carmine fluid. Carmine, 10 grains; strong ammonia, 30 minims; glycerine, 2 oz.; distilled water,

2 oz.; rectified spirit, ½ oz. Place carmine in a test tube, add the ammonia, boil for a few seconds, let stand for an hour, add the water, filter, and add the spirit and the glycerine. Allow to stand exposed to the air until the odour of ammonia is scarcely perceptible. The tissue may be steeped in this fluid, or it may be injected into the blood-vessels, and allowed to find its way through the capillary walls into the tissues. (Beale.) Remove superfluous pigment by macerating the tissue in glycerine 2 parts, water 1 part. Fix the pigment by placing the tissue in acid glycerine (5 drops glacial acetic acid, or 2 drops hydrochloric acid, to 1 oz. of glycerine). 2. Magenta, most useful for staining tissues immediately. Like carmine, it generally stains nuclei, nerve axial cylinders, &c. Unlike carmine, it fades, and therefore it is not suitable for permanent preparations. Two fluids necessary—*a*, 1 grain crystallized magenta, 100 minims absolute alcohol, 5 oz. distilled water. This is used for the tissues generally. The following is used for blood-corpuscles only:—*b*, Crystallized magenta, 1 part; rectified spirit, 50 parts; distilled water, 150 parts; glycerine, 200 parts. 3. Nitrate of silver, used for blackening epithelial cement in capillaries and lymphatics more especially, ½ per cent. solution of nitrate of silver in distilled water. Put the fresh tissue in this for one to three minutes, then in very dilute acetic acid (1 to 2 per cent.) for a minute or two, then place in glycerine and expose to the light. Mount in glycerine or glycerine jelly. 4. Chloride of gold, useful for staining nerve-fibrils. The colour produced is violet. Half per cent. solution of gold chloride in distilled water. Place fresh tissue in this for fifteen to twenty minutes, until it is of a yellow colour, then in dilute acetic acid (1 to 2 per cent.) for a few minutes. Then place in distilled water and expose to the light until a tinge which is sufficiently violet appears. Mount in glycerine jelly, &c. 5. Osmic acid, chiefly used for the retina. It blackens certain parts. (For the solution, see "How to harden Tissues.") Mount in saturated solution of potassium acetate.

How to Inject.—A. Blood-vessels. 1. Injection, fluid at ordinary temperatures. *a*, Beale's Prussian blue injection with glycerine (Beale 'How to Work'), excellent when a perfect injection is not desired. Preserve in acid glycerine (2 drops HCl to 1 oz. glycerine). *b*, Watery solution of soluble Prussian blue (see 'Jl. of Anatomy and Physiology,' vol. i, 1st series, p. 369), also good for injecting vessels when a perfect injection is not wanted. After injection with *b* precipitate the pigment inside the vessels by immersion in spirit (90 per cent.). 2. Injections solid at ordinary tempe-

ratures. *a*, Carmine injection (Carter's receipt). (See Beale, 'How to Work.') *b*, Blue injection (Ludwig's). Solution A. Gelatine, 50 parts; distilled water, 200 parts. Dissolve with the aid of a gentle heat. Solution B. Soluble Prussian blue, 4 parts; distilled water, 200 parts. Dissolve; add solution B to solution A gradually. All Prussian blue injections must not come near any alkali. The blood-vessels may be injected immediately after death, or after the rigor mortis has passed off. In the former case paralyse vaso-motor nerves by a blow on the head, or, if possible, section of the cervical spinal cord. After the latter beware of extravasation.

B, Bile-ducts; use soluble Prussian blue, with or without gelatine.

C, Lymphatics; watery solution of soluble Prussian blue most useful. The best demonstration of injected lymphatics is obtained from the testis of the dog. Take a Wood's syringe and thrust the nozzle through the tunica albuginea; inject the fluid slowly. It finds its way into the lymphatics readily. The thoracic duct may even be injected from this source. The lymphatics of aponeurosis may be injected in this way also (Ludwig). For other injections generally, abandon the syringe and use Wolff's bottles, with water pressure. Indicate the amount of pressure by means of a mercurial manometer. I arrange the apparatus in this way:—*a*, A large jar of water attached to a pulley, so that it can be elevated to any height. A long elastic tube with a stopcock is connected with the interior of the jar near its bottom, so that the water may flow out when required. The other end of this tube transmits the water into *b*, a large Wolff's bottle, having three apertures. The bottle contains air at the commencement. The water is permitted to flow in by one aperture, through a long glass tube which passes to the bottom of the bottle. The air is thereby driven out through the other two apertures, one communicating with (*c*) a mercurial manometer for indicating the pressure, the other transmitting the air through an elastic tube to *d*, a second Wolff's bottle containing the injecting fluid. This bottle has two apertures. The air is forced upon the surface of the fluid, and a glass tube, reaching nearly to the bottom of the bottle, transmits the fluid thence to an elastic tube joined to a glass or metal nozzle placed in the artery. Any number of Wolff's bottles corresponding to (*d*) may be added, so that different injecting fluids can be thrown in at the same time. The pressure can be regulated with the greatest nicety. There is no jerking, no refilling of

a syringe, no haphazard application of pressure, as is the case with the syringe. This invaluable method we owe to Ludwig.

How to Preserve Tissues.—1. In the dry way. Bone, tooth, hair. These may also be well kept in Canada balsam or Dammar. 2. In Canada balsam or Dammar. All water must be removed from the tissue by drying or by immersion first in methylated spirit and then in absolute alcohol. The alcohol is then driven away by floating the tissue upon oil of turpentine or oil of cloves, and then the balsam or Dammar is added, and the covering glass put on. I prepare the Canada balsam in this way:—*a*, Take pure Canada balsam and place it in a saucer or other shallow vessel. *b*, Cover the vessel with bibulous paper, to exclude dust. *c*, Dry it in an oven at a temperature not above 150° Fahr., until, when it cools, *it becomes as hard as ice*. *d*, Dissolve this crystalline balsam in chloroform or oil of turpentine. A solution in the former medium dries most rapidly, but a solution in turpentine is generally preferable for mounting sections of tissues. Now, balsam is being replaced by Dammar. I am indebted to Dr. Klein for the following receipt for this fluid. A, Gum Dammar ½ oz., oil of turpentine 1 oz.; dissolve and filter B, Gum mastic ½ oz., chloroform 2 oz.; dissolve and filter Add solution A to solution B. This, if rendered thicker by drying, may be used as a luting. Dammar or balsam, suitable for mounting. Unsoftened bone, tooth, hair, and most tissues which have been hardened in alcohol or chromic acid. 3. Glycerine suitable for all tissues that are not rendered too transparent by it; well adapted for tissues which are to be examined by very high powers. (Consult Beale, 'How to work With the Microscope.') Liver, lung, alimentary canal, and skin, after having been hardened in chromic acid or alcohol, show better in glycerine than in balsam or Dammar. The latter is apt to render them too transparent. For specimens containing carmine or Prussian blue add 2 drops of hydrochloric acid to 1 oz. of glycerine. Glycerine should not be used for mounting things hardened in osmic acid. 4. Saturated solution of potassium acetate, for mounting osmic acid preparations. 5. Glycerine jelly, good for connective tissue, softened bone and tooth, cartilage, blood-vessels, lung, &c. Steep tissue in weak spirit previous to mounting. Heat a lump of jelly upon the slide, gently place the tissue in it, and then put on the covering glass. 6. Weak spirit (methylated spirit 1 part, distilled water 3 parts), adapted for connective tissue, muscle, and blood-vessels. 7. Naphtha and

creosote fluid (see Beale's 'How to Work,' &c.), useful for urinary casts, pus, and epithelium.

Cells for Microscopic Objects.—A, For dry objects use cells made of tinfoil, paper, cardboard, dammar varnish, putty, or glass. B, For wet objects use glass cells.

Cements.—Don't use Brunswick black (asphalt). I find dammar varnish the best for common purposes. I use a thick solution of gum dammar in benzole (*not benzoline*). The very best varnish is, however, the Dammar mounting fluid (see above) thickened by drying.

On the PERIPHERAL DISTRIBUTION *of* NON-MEDULLATED NERVE-FIBRES. By Dr. E. KLEIN, Assistant-Professor at the Brown Institution Laboratory (with plates I—IV.)

PART II.[1]

A. *Nerves of the Nictitating Membrane.*

IN the first part we gave a full account of the methods by which the nerves of the cornea are made out, both in the rabbit and in the frog; and, at the same time, we took the opportunity of asserting that, provided these methods are adopted, no difficulty whatever will be experienced in following out the finest nerves to their extreme ramifications.

It is not such a simple matter with the nictitating membrane of the frog. In the first place, in the case of this membrane, we have to do with an organ possessing a structure of extraordinary complexity. In the thin nictitating membrane there are crowded together, on a comparatively small extent of surface, structures widely different in kind; as, for example, two varieties of epithelium, glands, a rich network of blood-vessels, and very abundant cellular structures of various appearance and properties, from all which result very complicated relations of the nerves. In the second place, the following out of the finest non-medullated nerves in gold preparations (and only such preparations can

[1] I find, at the last moment, that I am compelled to give a third part in the next or April number; first, because I have not been able to introduce into the present one all the plates I had prepared (on account of the necessary limitation to the number of illustrations in each part); and, secondly, because I have arrived at several new facts respecting the nerves of the tongue of the frog. These and the nerves of the ciliated passage found in the tail of the rabbit will make up the subjects of Part III.

be suitably employed) is rendered extremely difficult by the fact that, with the exception of the cellular structures of the proper tissue of the membrane, all its constituents which we have enumerated possess nearly as much power of combination with the gold salt as do the nerves themselves. It is thus only in some few cases that the finer nerves can be successfully traced out. Among these cases are those in which the epithelium of both surfaces can be removed without thereby seriously injuring the tissue of the membrane. In the case of the cornea it is an easy matter to remove, over a considerable area, the anterior epithelium with a thin layer of the proper tissue, and even to prepare thin layers from the residual tissue; but this is by no means the case with the nictitating membrane. In it, indeed, although it is well known not to exceed the cornea in thickness, we have first a thin epithelium on either surface, and, besides this, the fundamental tissue possesses a peculiar structure, which is found in the cornea, to a limited degree only, in its most posterior layers. This peculiar arrangement is as follows:—The stroma of the nictitating membrane consists of connective-tissue bundles, as a rule running parallel to each other, and arranged in three layers, a middle and a superficial corresponding to each surface. The bundles of the two last do not remain near the surface during their whole course, but bend away from it, the fibres of each bundle being compressed into a thin cord, and running in a narrow cylindrical canal which pierces the membrane in a vertical direction, so that they emerge at the opposite surface once more, and there run parallel with it. Whether these vertical bundles of connective tissue all extend from the one surface to the other, or whether on their way they are not in connection with the bundles of the middle layer, I cannot distinctly say; this much is certain, that the nictitating membrane is pierced by regular and tolerably compactly arranged canals, in which the bundles of the one surface reach the other.

From this it is plain that the attempt to split up the nictitating membrane must be unsuccessful, and that the most we can do is to detach small portions, which can be made use of only for tracing the nerves in the epithelium. For following up the nerves of the blood-vessels and glands, and for determining the relations of the cellular structures, the portions thus removed are of no importance worth mentioning, since no preparations are of any use for these purposes except those in which the tissue of the membrane is present *in toto* without the epithelium of the surfaces. Out of a disproportionately large number of nictitating membranes

I have obtained but a limited number of preparations adapted to solve these problems in a thoroughly unexceptionable manner.

The method which I adopt in producing any specimens is the usual one of colouring with gold; the treatment of the gold-coloured membrane with tartaric acid, which was used in the case of the cornea of the rabbit, has yielded in my hands only in a very few cases moderately useful results, and the same is true of the more rapid reduction of the gold salt by means of gentle heat. In both cases the very serious inconvenience arises, that the membrane shrinks in a remarkable degree, curls itself up, and so forth, in such a way that no further preparation is possible without considerable mechanical injury.

The method which I pursue is as follows:—I separate the nictitating membrane on the living frog (*Rana esculenta*), in the neighbourhood of its thick muscular attachments, with a few cuts of the scissors, transfer it with the greatest caution into a few drops of a half per cent. solution of chloride of gold, where I allow it to remain from three quarters of an hour to an hour. I then remove it to distilled water, in which it is kept exposed to the light a sufficient number of days to acquire a perfectly dark red or black colour. The objects may without damage remain for a week or more in water, and, indeed, this long soaking brings with it the advantage that the epithelium of the surfaces becomes macerated and loosened, and may then be removed for large extents of surface by simple pencilling with a thick camel's-hair brush under water. Objects so prepared are examined in glycerine.

We now turn to the consideration of the nerves of the nictitating membrane.

The trunks of the medullated nerve-fibres are united to form a plexus; that is to say they divide into branches, which, constantly diminishing in size, contain only single or a few medullated fibres (distinguished, as is well known, by their tendency to divide), and by these branches they are connected. To these trunks and branches we shall give the name of *nerves of the first order*. In these the neurilemma appears generally in gold preparations strongly developed, and possessed of oblong nuclei. Helfreich (29) has described these medullated nerves in detail.

In a fresh nictitating membrane, which has been prepared with the necessary caution, and is examined in serum, the space within the neurilemma filled with lymph, which Stricker (29) has described, may often be seen with the greatest distinctness, both on the larger and on the

smaller branches of this plexus. If we follow, for instance, a small trunk, containing, say only two medullated fibres, we shall see, for a greater or less extent, that neither of the nerve-fibres which sometimes cross each other or wind round each other comes into direct contact with the delicate neurilemma (easily recognised by its nuclei); but we shall observe, instead, that the one is separated from the other on both sides by a clear interval.

The more the trunks of the plexus of nerves of the first order divide into smaller trunks, the more we see the nerves which lie within them passing into non-medullated fibres. The latter appear as bundles varying in breadth, of fine fibrillæ, furnished with variously sized granular swellings at more or less regular intervals, and running, just as has been already shown in the nerves of the cornea, in places simply lying close together and wavy, in other parts twisting round or forming a reticular connection with each other by giving off little lateral threads. The latter relation comes distinctly into view at the three-cornered expansions corresponding to the anastomoses, of the branches of this plexus. The whole bundle is imbedded in a pale sheath, which becomes but little coloured by chloride of gold, and on which we are just able to recognise a striation here and there. The sheath always contains, although not in great numbers, nuclei of an elongated shape. These appear of various size, and are in gold preparations sometimes coloured uniformly dark, with a sharp outline, at other times seen as clear structures with a double contour, and containing in their interior a few minute granules. These bundles of fibrils we shall call *nerves of the second order.*

Here we meet with a relation similar to the one which we indicated in the case of the corneal nerves, existing, on the one hand, between these nerves of the second order, and the small trunks of the first order from which they have proceeded; and, on the other, between the sheath in which they are imbedded and the neurilemma of these trunks. A small trunk of the first order, which, *e.g.*, contains within its sheath only a single medullated fibre, passes over undivided into a bundle of fine fibrillæ; or, instead, it divides into two or three smaller but similar little bundles, which remain separated in their further course; or, instead, we see a small trunk of the first order containing two medullated fibres pass abruptly into a combined bundle of the finest fibrils, which in its further course gives off several smaller lateral bundles.

Where those nerves of the second order originate we may

easily convince ourselves that the sheath in which they are enclosed represents a direct continuation of the neurilemma of the small trunks. The nerves of the second order, which, therefore, occur generally as a bundle of fine fibrils only, furnished with granular swellings, divide into little bundles, which constantly diminish in thickness. These—*nerves of the third order*—are connected with each other. With higher powers we are not able to recognise here any other connection than a plexus, namely, a simple close arrangement of the constituent fibrils. A nucleus belonging to the sheath is no longer to be observed. Their course is for the most part sinuous, but becomes, under the epithelium, more rectilinear, like the fine nerves of the cornea; only that in the nictitating membrane, similar rectilinear fibres, having granules imbedded in them at regular intervals, may be observed in a few places in the substance, at some distance from the epithelium.

Close under the epithelium of the posterior surface there proceed from these, numerous very fine filaments, with a straight course, and always distinguished by granular swellings—*nerves of the fourth order*—which run always in a certain place in a certain direction. They unite to form a subepithelial network by means of small transverse threads, and thence penetrate between the epithelial cells of the deep layers in an oblique, or, more rarely, in a vertical direction. They are likewise furnished with small varicosities, and pursue between the cells a zigzag or abruptly winding course. Between the cells of the superficial and the deep layer they bifurcate or give off gradually lateral horizontal branches. These finally unite laterally to form an intra-epithelial network, which in abundance of threads is not inferior to the deep intra-epithelial network of the cornea of the rabbit.

In the preceding description we have noticed the distribution of the non-medullated nerve-fibres in general; now we turn to consider the relation of these to the blood-vessels and glands. It is known that Kessel (30) asserts, in the case of the membrana tympani, and Tomsa (31), in that of the papillæ of the skin, that a connection exists between the fine non-medullated nerve-fibres, distinguished by their nuclei, and the oblong nuclei of the capillary wall; (Kessel considers this only probable; but Tomsa, on the other hand, expresses a very decided conviction). Through the conclusions which I draw from my preparations I am not only unable to confirm the existence of such a connection in the capillaries of the nictitating membrane, but I must deny it.

In the nictitating membrane we find that numerous nerves, which we have designated nerves of the second order, approach

a capillary vessel or a small vein, and when they have come quite close up to it, we see them divide into two branches. At the point of division we notice an oblong nucleus. Now, one of the two branches remains on the same side of the vessel, and accompanies it for some distance, while the other passes across the vessel, either obliquely or at a right angle; arrived at the other side, it bends away and travels now in the same direction as its partner, close to the vessel, or else it leaves the vessel after first sending off a fine branch which accompanies the same.

The fibres twine around the vessel in many cases once or more; they give off, in every case, finer twigs which correspond to the above-mentioned nerves of the third order. By the union of these there is formed a rich plexus, which surrounds the vessel just like a kind of nervous sheath. Finally there proceed from these very fine threads, which correspond to the nerves of the fourth order, and here possess granular swellings. They lie for the most part in the vascular wall, divide dichotomously, and are finally united to form a network. On surface views there is certainly no small difficulty in deciding whether such a structure as a fine nervous thread, which can just be followed by No. 8 Hartnack, courses in or on the wall of the capillary; but in the case of which an illustration is given in fig. 5, I believe I can speak with certainty; *a* represents a capillary filled with blood-corpuscles. I can now, with the No. 10 immersion, follow the one or the other thread quite distinctly to the plane, immediately under which, by the very slightest turn of the micrometer screw, the most superficial blood-corpuscles come into view; this layer I find again leaving and running towards the other side. Thus I am justified in assuming that threads do course within the wall of the vessel. I must once more insist upon it as a fact that these threads have nothing to do with the intercellular cement-lines of the endothelium of the capillary, but are nerve-threads; on account both of their course and of their characteristic appearance, they can be considered as nothing else; for this further reason, too, above all, that I am able to follow them from unmistakable nerve-fibres with any amount of certainty that can be desired. I was never able to find such a thread connected with the nucleus of the vascular wall, and that after careful investigation, although I considered such to be the case on superficial observation. What the authors named above describe as the finest nerves on the capillaries are not by a great deal the finest nerves.

To recapitulate, in a few words, the relation of the nerves to

the capillary blood-vessels, we find that the nerves of the third order form a perivascular plexus, out of which there proceeds a network of filaments of the fourth order, which belongs to the wall of the vessel.

The relation of the finer nerves to the glands of the skin of the frog has lately assumed greater importance since Engelmann (*32*) has demonstrated that the gland-cells are contractile, and that this contractility is of essential importance for secretion. The glands of the nictitating membrane are analogous to those found on the web and other parts of the skin; what, therefore, we affirm regarding the nerves of the former we may regard as applying to the glands of the skin in general. Our investigation refers, however, only to the relation of the nerves to the body of the gland; regarding the duct, we have here nothing to say.

As in capillaries, we see in the case of the glands nerve-fibres of the third order, leaving with a tortuous course the nerves which are still furnished with a nucleated sheath, and belong to the second order. In the immediate circumference of the body of the gland they unite by lateral branches to form a plexus which envelopes it. (We have remarked above that these nerve-fibres represent small bundles of fibrils, so that at the union of two nerve-fibres there does not result a reticulate, but a plexiform union of the fibrils.)

The filaments of the fourth order proceeding from this plexus, pursue their course through the membrana propria of the gland (which is furnished with oblong nuclei), and then run between the gland-cells.

If we carefully direct our attention, at a spot where the gold-colouring is not very intense, to the wall of the gland-body seen in profile (the preparation is arranged with the bottom of the gland looking upwards), we see the following appearances. External to the gland-cells, which consist of an uniformly granular protoplasm, possess a nucleus (lying in the outer third of their area, mostly oblong, less often rounded), and are shaped sometimes cubically, sometimes cylindrically and conically, there is a thin clear double-contoured wall, in which oblong nuclei appear at regular intervals. If we confine our attention to the body of the gland, in this case to the most superficial plane in which the *gland* can possibly be seen, we observe branched structures, which are coloured somewhat more deeply than the gland-cells, penetrate by their processes between the gland-cells, and seem to blend with the intercellular cement of the same: in these structures there is sometimes to be observed an oblong

clear nuclear body. It is evidently not rash to look upon these flat branched structures which we have just described as the surface appearance of the external wall which was previously mentioned in the profile view as containing oblong rod-shaped nuclei; indeed, we need the less hesitate to do so since Boll (33) has demonstrated that what is called *membrana propria* in glands in general, is not structureless membrane, but a network of flat-branched cells, which are bent in a basket-like manner to correspond with the alveoli of the glands.

If we now follow the nervous filaments of the fourth order, which penetrate the wall of the gland, we may see them simply making their way between the gland-cells, bifurcating in their course and uniting with each other in a retiform manner. This, indeed, is all that we are in a position to say with certainty; on account of their plane being identical with that of the intercellular cement of the gland-cells, they elude all attempts to trace them further with certainty. As far, however, as we can follow with certainty between the gland-cells their independent filaments, distinguished as they are by their colour and granular swellings, we cannot demonstrate a connection on their part with any of the cellular structures of the gland.

Up to this point we have treated of the division of the finer nerves in the tissue of the nictitating membrane, and of their relation to the epithelium, blood-vessels, and glands. There is still another subject which we have to discuss before leaving the nictitating membrane, and that is the cellular structures. On a membrane which has been successfully coloured with chloride of gold, and from which most of the epithelium of both surfaces has been removed, we may recognise, if we employ higher powers (8, 9, 10), large flat and, as a whole, oblong structures situated in the middle layers of the membrane, and consisting of protoplasm furnished with granules, in some places finer, in other places coarser. In the interior of this protoplasm also lies a sharply contoured, oblong nucleus which is sometimes smooth and sometimes crenate, in which again there are always to be observed one or two large shining nucleoli. At times there are besides these other finer granules. What is easily determined in all these structures is this, that their body is prolonged into a number of longer or shorter processes of various thickness, which are mostly branched, so that the further they are removed from the body of the cell the more attenuated they become, and which unite with those of the neighbouring cells. See Pl. II, fig. 7.

It is plain we have here to do with the same cellular structures so often and so well described and represented in the case of the cornea. In regard to a special relation of these cells to the fine nerve-fibres, as was described in the cornea, I have nothing to say. I find, of course, as I have already remarked above, very fine nervous filaments in the tissue of the nictitating membrane, which belong neither to the capillary vessels nor to the glands; fine nervous filaments, which follow a perfectly straight course, are distinguished by regular granular swellings, and have been denoted by us as *filaments of the fourth order.* I have never seen any special relation of these to the above cells.

The opposite appears to be the case with the pigment-cells. For we find on the one hand nerve-fibres which cross either the body or a process, or sometimes accompany a process for a short distance, or, finally, we see a nerve-fibre run up to the body or a process, after which it withdraws from further pursuit. On the other hand, we sometimes see a process of a pigment-cell running out into a filament, the substance of which is sometimes pale, and seem to possess in some cases coarser, in other cases finer swellings; seen from the surface this appears not quite unlike a nervous filament. We shall return to these structures below.

If we study the pigment-cells which come into view on gold preparations of the nictitating membrane, we find them singly in its substance or lying together in smaller groups (2-4); they resemble roundish or oblong clusters, which possess in one place or another a short sharp or blunt process, or, on the other hand, exhibit the richly branched processes of various length. For example, if we study a group of pigment-cells as they are represented quite true to nature in fig. 9, with a rather low power (Hartnack 5 or 7), we find they appear as branched structures which, on the one side, appear somewhat sharply broken off; while towards the other they spread out their arborescent processes as a cephalopode its tentacles. We remark further that the processes do not all break off sharply, but that they are produced further with more or less indistinct outlines, though still there are others which terminate boldly and abruptly. If examined more attentively with a high magnifying power (such as No. 10 immersion), they present the appearance delineated in the figure; one very different from that just described. In the first place, it is noticeable that the distribution of the pigment is by no means coincident with the extent of the cell itself. The body of all three cells is strengthened on one side, and in this part is furnished

with an oblong nucleus, containing a relatively large nucleolus. The whole of this part of the cell-body is destitute of pigment; and the nucleus itself is only to a small extent covered with pigment-granules. Furthermore, it may be seen that the processes also, both those which appear with a low magnifying power to terminate abruptly and those which are indistinctly defined, can be traced outwards far beyond the limits of the pigment, and that the processes of two adjacent pigment-cells are connected together just in the same way as has been described in the case of the non-pigmented cells. In those parts which are free from pigment both the processes and the body of the cell appear pale and finely striated, as if composed of fibrillæ. It is, in fact, noticeable that in those parts where the pigment granules lie less closely together (as is generally the case in the fainter parts), the pigment-granules are arranged in rows, as if placed simply one behind another between the fibrils. Occasionally, one or two such rows of pigment-granules may be found imbedded in a comparatively broad process, and extending from one cell to another; or, on the other hand, a very broad process may be seen, with a narrow middle zone filled for a short distance only with thickly crowded pigment-granules. Moreover, in those pigment-cells, which have, as it is usual to say, completely "retracted their processes," and thus assumed the form of spherical or oblong black masses, it is not hard to make out that the pigmented mass by no means constitutes the whole cell, but that there exists besides this—perhaps a part of the body of the cell—certainly a number of broader or narrower processes which are branched, pale, and more or less distinctly striated.

The objection may be made that these appearances (which I have just described from a gold preparation) are not sufficiently convincing to establish the conclusions I have drawn, viz. that the pigment-cells are branched cells, which retract the pigment-granules, but not the processes; that the pigmented portion gives no decisive indication of the magnitude of the cell-body or of the shape and size of the processes; and again, that the pigment-granules are arranged between the fibrillæ of the protoplasm of the cell. This objection may be met by the following observation:

A nictitating membrane was carefully prepared with all due precautions, and placed under a cover-glass with a drop of *humor aqueus*, the pressure of the glass being removed by the well-known expedient of placing thin strips of paper by the side of the object; the whole was then closed at the

edges with oil. After a short time I was occasionally able to hit upon a single pigment-cell, which had, in the language of the authors, retracted its processes almost completely. I was then able, in an hour's time or more, to convince myself with positive certainty of the existence of pale and, in parts, clearly striated processes, although the pigmented portion had undergone no kind of change.

I believe, then, that I have justified the statements made above, and am, thereby, in agreement with Lister (34), who, as is well known, attributes the alterations in the pigment-cells of the web of the frog's foot, in part at least, to a transference of pigment-granules from the processes to the body of the cell, and *vice versâ*.

Let us now return to our gold preparation, and more especially to the three pigment-cells. There is one other fact beside the relations mentioned above, which we are able to establish; it is this: the pigment-cells are connected by their unpigmented processes, not only with one another, but also with the ordinary smaller branched cells of the nictitating membrane. I have seen this relation, it is true, with perfect certainty only in a single instance (and I wish to state this before going further); the instance was that of the cells marked *e* and *b* in figure 9, but this with such distinctness that I cannot hesitate to give it a general application.

We occasionally come, in gold preparations, upon a pigment-cell from which there is given off a very thin and pale process, appearing to taper to a point, and containing, at the same time, pigment-granules arranged at tolerably regular intervals behind one another. Considering that a fine nerve-fibre may be seen running close by, and this also possesses dark granular enlargements, we might easily fall into the error of mistaking this process for a detached nervous thread. With a higher magnifying power we can, however, easily convince ourselves of its very different colour.

All pigment-cells of the nictitating membrane are not, however, identical in appearance with those which have been just described. In the superficial layers of many such membranes, and especially in the neighbourhood of the pigmented border, there occur pigment-cells of the type represented in fig. 8. They are of a bluish-gray or bluish-green colour, contain very minute and regularly distributed pigment-granules; their processes (in opposition to those of the pigment-cells formerly mentioned, as well as to those of the ordinary branched cells) possess nodular swellings of very characteristic appearance. In point of size these cells are intermediate between the

two sorts previously described. They are connected with the more deeply situated cells.

Finally, we have to make mention of the beautiful stellate cells supplied with fine pigment-granules, which are found on the nictitating membrane, especially between the cells of the more superficial as well as deeper layers of the epithelium of the outer surface. In the body of the cell (which varies considerably in size), is contained an oblong or roundish nucleus; its processes are exceedingly long and abundantly ramified.

The smaller branches, which can always be clearly traced by their pigment-granules, run in the cement substance between every two epithelial cells, forming, by junction with one another and with the branches of neighbouring cells, a network, the meshes of which vary in size according to the abundance of the ramification, sometimes being so small as to enclose only a single epithelial cell, sometimes so large as to encircle a group of them.

B. *Nerves of the Peritoneum.*

In the following pages will be described the distribution of nerves in the frog's mesentery and in the septum which extends between the *cisterna lymphatica magna* and the peritoneal cavity of the same animal.

The minute nerves of the mesentery are somewhat difficult to demonstrate; the simple method of gold-tinting often fails to secure the desired end. The preparations from which the figures in Pl. IV were taken were prepared in the following manner:—A frog (*Rana esculenta*) was decapitated, and the whole mesentery, with the intestine, cut off at its attachments. This was then placed for an hour in a half-per-cent. gold solution, and next exposed to the light in a quarter per cent. solution of acetic acid till it had acquired a distinct violet red colour, which required four or five days.

The mesentery was in the next place separated from the intestine, and divided into several parts. These were brushed off from both surfaces under water with a fine camel's-hair brush, and next transferred to a watch-glass containing a small quantity of not very dilute ammoniacal carmine solution containing an excess of ammonia, in which they were allowed to remain about ten minutes. After this they were washed also for a few minutes in the quarter per cent. acetic acid solution, and finally mounted in glycerin. The septum of the cisterna lymphatica magna is prepared in precisely the same manner.

As is well known, the larger nerve-trunks in the mesentery, which consist of medullated fibres, and run a more or less winding course, accompany the larger vessels from the mesenteric attachment towards the intestine. They give off comparatively few smaller branches, which are also sinuous, and, further, are united together to form a network, the meshes of which, from the small number of branches, are very wide.

The branches of this plexus we will, for the sake of clearness, call nerves of the first order. The medullated nerve-fibres of which they consist lie generally close together; numerous oblong nuclei may be observed on their trunks, as well as here and there isolated ganglion-cells, such as are met with also elsewhere in the course of the sympathetic nerves.

From the smaller twigs of this plexus single nerve-fibres are given off, which lose their medullated structure immediately after they become separate. At certain spots these fibres are obviously composed of fibrils exhibiting granular enlargements; the sheath in which they are contained is comparatively broad, and contains numerous oblong nuclei; they divide (although not very frequently) into finer fibres, and form by their union a plexus with wide areas, the branches of which we will call nerves of the second order. These nerves also are still provided with a nucleated sheath. From this plexus there proceed, again, minute nerve-fibres, and these are far more numerous than would be anticipated from the inspection of ordinary preparations.

These nerve-fibres, which we will call *nerves of the third order* also run for the most part a winding course, but sometimes bend abruptly at right angles to their original direction, and finally give origin to very minute threads, the *nerves of the fourth order*, which exhibit granular enlargements, and are ultimately united into a network composed of almost rectangular meshes.

The point to be noticed in the nerve-fibres which we have called nerves of the third order, in contradistinction to those described from the nictitating membrane, is that they exhibit, at intervals, enlargements caused by oblong nuclei. These enlargements are, nevertheless, in reality by no means so numerous as they appear to be when viewed with a low magnifying power (such as Hartnack's objective, No. 7), since at many points where a nucleus appears to be intercalated in the course of the nerve-fibres, a higher magnifying power (No. 9 or No. 10 immersion of Hartnack) shows the appearance to be due to nothing more than a close apposition of the fibres.

In the septum of the cisterna lymphatica we find the same relations which have just been described, repeated. Cyon (37) describes non-medullated fibres from this septum which are distinguished by the oblong nuclei intercalated in their course, and have a striated appearance; these he represents as running free in the tissues. With respect to the latter point, I cannot agree with Cyon, since I am able to trace in my gold preparations far finer nerve-fibres than Cyon has seen; and these, as I have stated, are united into a network.

We find in the larger and middle-sized arteries and veins, nerves of the second order which run in the adventitia and there give off numerous fine fibres; these are united into a network situated in the innermost parts of the adventitia; they have, generally speaking, in the arteries, a less distinctly sinuous course than in the veins. In illustration of this point, I would refer to those represented in Pl. IV, figs. 12 A and 12 B. With respect to the nerves of the inner vascular walls I cannot make any assertion worth recording.

In the smaller veins and capillaries we find just the same relations as in those of the nictitating membrane. We will just mention, although it is repeating what has been already said, that here also non-medullated fibres of the second order, provided with a nucleated sheath, surround the vessels in a complicated manner and give off branches—nerves of the third order—which are united into a plexus forming a sheath around the vessel; finally, there arise from these exceedingly fine nervous threads, nerves of the fourth order, which form a network in the vascular wall itself. No connection between a thread of this kind and a nucleus of the vascular wall is demonstrable.

Before closing these remarks, we wish to say a few words respecting the pigment-cells which occur in the mesentery and in the septum of the cisterna lymphatica. It is by no means our object to describe the anatomical relations of the pigment-cells in the fresh state and in gold preparations; since we should have nothing to add to what has been already brought forward with respect to the nictitating membrane, and might, therefore, be afraid of too severely taxing the patience of our readers. I may, however, just be allowed to state that in the pigment-cells of the large arteries of the fresh mesentery, cells which resemble black spherical lumps, I have repeatedly, by the addition of a few drops of a one-per-cent. solution of acetic acid, convinced myself of the presence of numerous ramified unpigmented processes.

In the subjoined plates, Plate I, fig. 1, contains the repre-

sentation promised in the first part of our paper, of the finest subepithelial nerves of the cornea in the rabbit.

I may further be permitted to supply an omission in the first part by now mentioning the researches of Th. W. Engelmann (35), and Lippmann (36),[1] on the nerves of the cornea. Engelmann confirms the statements of Cohnheim on all important points; he separates the nerves of the cornea into those of the corneal tissue and those of the epithelium, and questions the existence of a connection between the minute nerves of the corneal tissue and the corneal corpuscles; while Lippmann professes to have seen a union of the minute nerves with the nucleolus of the corneal corpuscle.

REMARKS *on* PROF. SCHULZE'S MEMOIR *on* CORDYLOPHORA LACUSTRIS. By PROFESSOR ALLMAN, F.R.S.

('Über den Bau und die Entwicklung von *Cordylophora lacustris*, Allman. Nebst Bemerkungen über Vorkommen und Lebensweise dieses Thieres.') Von Dr. FRANZ EILHARD SCHULZE. Leipzig, 1871.

A MEMOIR with the above title has recently been published by Dr. Schulze, of Rostock. The author obtained the remarkable hydroid which forms the subject of it in brackish water in the neighbourhood of Rostock, and he has subjected it to an elaborate and exhaustive examination. He identifies it, moreover, with a hydroid which under the name of *Tubularia cornea* was described by Agardh as long ago as 1816, in the 'Transactions' of the Royal Academy of Stockholm.

Dr. Schulze's memoir is in many respects a confirmation of my own researches on the structure of *Cordylophora* published many years ago. In some points, however, it differs from the account which I then gave, but which I have in later publications supplemented and amended. Still, however, the author adduces several facts now for the first time published, and though I have as yet had no opportunity of verifying these, I am ready to accept most of them, as Dr. Schulze's observations appear to have been made with great care and by means of trustworthy methods of research.

By the aid of osmic acid he has succeeded in killing the animal before retraction was possible, and has thus retained

[1] The references indicated by these figures will be given in the concluding part of our paper.

it with its tentacles and other parts extended, and at the same time hardened by the reagent so as to allow of sections being made for microscopical examination. In some cases he subjects these sections to subsequent maceration in Müller's solution, and the iodine and serum solution, and then examines them for minute structure under Gundlach's or Hartnack's No. 9 immersion lens.

He has thus succeeded in making out with great detail the minute structure of *Cordylophora*, and I propose to give here some account of the more important results of his examination.

After confirming the cellular nature of the ectoderm and the endoderm, and the existence in certain parts of the animal of a fibrillated muscular layer between the two, as described in my original paper on *Cordylophora lacustris*, he maintains the important additional fact of the existence of a structureless hyaline membrane, which also lies between ectoderm and endoderm, and in those parts where the muscular layer exists, at the inner or endodermic side of this layer.

This hyaline membrane is the supporting lamina, "stützlamelle" of Reichert, who recognises its presence in the same position in other hydroids, though he asserts that I confounded it with my muscular layer whose existence he altogether denies, while he maintains that there is no true cellular structure in the ectoderm.

I am willing to accept Reichert's demonstration of this hyaline "stützlamelle" confirmed as it is by the more recent researches of Schulze. Indeed, I have been long aware of the appearance of a narrow clear space between the ectoderm and endoderm as visible in sections of many hydroids, and have in many cases represented it in my published figures, though I could never convince myself that the appearance here of a narrow hyaline space ought to be regarded as the expression of an independent membrane. Schulze's mode of investigation, however, appears to me now to set this question pretty much at rest, and to justify us in regarding the "stützlamelle" as a second element lying between ectoderm and endoderm, the muscular layer being the other.

The formation of the endoderm of the hydranths and cœnosarc out of a single layer of large elongated cells very similar to those described and figured by myself, is also maintained by Schulze, but he can in no case find the secondary cells which I have described as existing in the large endodermal cells, and to which I believed myself justified in assigning a secreting function.

Notwithstanding our author's very reliable method of investigation, I am not prepared to relinquish my belief in these secondary cells, more especially as I believe my conclusions supported by an examination of other hydroids, though Schulze could no more find them in *Hydra* than in *Cordylophora*. It is by no means impossible that their existence may depend on conditions of nutrition, and that they may be present at certain times in the life of the hydroid and absent at others.

The author is inclined to regard the free ends of the endodermal cells as destitute of membrane, and believes that the protoplasm which is accumulated at this spot has its surface freely exposed to the lumen of the stomach and of the cœnosarc, an important and interesting fact if confirmed by subsequent observations.

He has also succeeded in clearly establishing the presence of cilia over the whole of the endoderm of the somatic cavity, each of the endodermal cells carrying a single long fine cilium on its free surface.

Those cilia had entirely escaped me in my original investigation of *Cordylophora*, but I have since found them very distinct in other hydroids, and have long been convinced that my failure to discover them in *Cordylophora* was owing to the imperfection of the means of investigation then at my disposal. The researches of Kölliker have also shown their general distribution in the Hydroida. Schulze and Reichert have seen them in *Hydra*, where I have been more doubtful of their presence than in other hydroids.

The existence of the longitudinal ridges which I have described in the stomach-walls of *Cordylophora* has not been confirmed by Schulze, who regards the appearance of these ridges as accidental and merely the result of the contraction of the stomach-walls. There can be no doubt, however, of the presence of more or less definite rugæ in the endoderm of the stomach of other hydroids, though in extreme dilation of this cavity they may become nearly effaced, and I cannot help thinking that their absence in the specimens of *Cordylophora* examined by Schulze was owing to their obliteration by the undue mechanical extension to which the surface under examination was subjected.

The structure of the tentacles of *Cordylophora* has especially engaged our author's attention, and he denies the existence in them of the continuous axial cavity, which I at one time believed to characterise them. In this I am ready to concur with him. I have long since given up the idea of a continuous cavity running through the whole length of the

hydranth-tentacles in the great majority of the marine hydroids, though of its existence in some others as well as in the marginal tentacles of many Medusæ there can be no doubt. The peculiar septate non-tubular pith which is so very characteristic of the tentacles of the marine hydroids generally, has been already fully described and figured by me ('Gymnoblastic Hydroids,' p. 126, pl. iv, fig. 5, woodcut, fig. 48, &c.), but I still maintain that in most cases the axis of the tentacle continues pervious for some distance from its base, and that the large cells which, with their conjoined walls like so many transverse septa, obliterate its cavity higher up, constitute a tissue which has been formed from a direct continuation by the endodermal cells of the Hydranth. In the figures referred to I have represented this tissue composed of a pile of cells, each with its nucleolated nucleus and with its contained protoplasm often sending off exactly as in certain vegetable cells, radiating and branching processes.

Our author further describes a transverse septum with a central perforation at the base of each tentacle. This septum he regards as an annular process of the "stützlamelle." I have never seen it.

We know that in *Cordylophora* and many other hydroids the spadix or endodermal blind pouch which extends into the axis of the gonophore from the somatic cavity, instead of remaining simple becomes divided into branching tubes. In my description of *Cordylophora lacustris* I represented those branches as here and there inosculating with one another. Schulze cannot confirm the existence here of a true inosculation, and believes that the appearance of such is deceptive, and caused by the close approximation of the branches where they lie upon one another. This is possibly true, and though I believed at the time that I had sufficient evidence of a true inosculation I do not now desire to insist on my own interpretation of the appearances presented. In other cases where I have found a branching spadix the branches certainly show no inosculation.

But a more important statement is made by our author with regard to these branches of the spadix in *Cordylophora*, for he informs us that they are entirely invested by a prolongation of the hyaline "stützlamelle." If this hyaline structureless tube lies between the generative elements and the spadix, as asserted by Schulze, it has certainly escaped me, not only in the spadix of *Cordylophora* but in that of all the other hydroids which I have examined; and yet, as I did not employ the special reagents used by Schulze in the demonstration I should be willing to believe that I had over-

looked it, were it not that its presence in this place is inconsistent with what seems to be the true origin of the generative elements.

With regard to the origin of the generative elements, Schulze views them as ectodermal products. In this I cannot agree with him. I believe I have satisfactory evidence of their endodermal origin in several marine hydroids. There can be no doubt that in these the generative elements, which in all cases lie between the ectoderm and endoderm of the gonophore, become more and more mature as they recede from the endoderm which confines them internally, a fact which is scarcely compatible with any other view than that they are products of the endoderm with which the young portions of the mass are still in connection rather than of the ectoderm.

It is true that if the "stützlamelle" as Schulze supposes, can be proved to invest the spadix at this period, and to form a continuous and unbroken layer between it and the ova or spermatozoa, a strong argument for the ectodermal origin of the generative elements would be afforded, but, with the very decided evidence we possess of their origin from the endoderm, I must suspend my belief in the validity of this observation.[1]

The author has followed the development of the embryo through its planula stage. In this stage he believes he has detected the foundation of the "stützlamelle" between endoderm and ectoderm, though unable to isolate it as an independent membrane. He could as yet detect no cilia on the endodermal cells, whose free ends seem to be as in those of the fully developed hydroid deprived of membrane. He admits that in the young tentacles of the developing hydroid the endoderm which clothes the internal cavity of the body is continued into the solid core of cells which forms their axis, and he follows Kölliker in regarding this as a proof that true epithelial cells may be transformed into a tissue which just as undoubtedly belongs to the connective substances as the tissue of the *Chorda dorsalis* or of cell-cartilage.

With regard to the mode of life of *Cordylophora lacustris*—the only species which he recognises—he believes this hydroid to be truly a brackish-water animal. There can be no doubt

[1] Indeed, I now believe that the very delicate, clear, structureless membrane which I have elsewhere described as being in many cases carried out, hernia-like before the ova when these are expelled under pressure from the gonophore, is nothing more than this "stützlamelle." If so, the ova must have been produced *between the latter and the spadix*. I believe too that I have in some instances, as in *Laomedea caliculata*, a hydroid with a branching spadix, detected a delicate structureless membrane *passing over* the ova while these are still in contact with the spadix.

of its frequenting brackish-water and of its growing in it with luxuriance, but we also know of its occurrence not only in water in which the trace of marine admixture has been quite too small to justify the epithet of brackish, but even in water which has been absolutely free from any such admixture. I believe that this interesting and beautiful hydroid has been introduced into this country on foreign timber, and that it is now like the freshwater mollusc *Dreissena polymorpha* which seems to have had a similar introduction, gradually advancing inland by our canals and rivers.

SIZE *of the* RED CORPUSCLES *of the* BLOOD *of the* PORBEAGLE *or* BEAUMARIS SHARK (*Lamna cornubica*). By GEORGE GULLIVER, F.R.S.

HAVING been present at the landing of this fish at Hastings, November 10th, 1871, I took the opportunity of procuring some of its blood. The fish was a male, eight feet three inches in length, and 305 pounds in weight, and was taken in the herring nets a few miles off Rye. I lost no time in sending to Professor Flower a notice of the capture, and he has secured the entire animal, so that we are likely to have a good account of it in the Museum of the Royal College of Surgeons. The mean long diameter of the red blood-corpuscles of the Porbeagle measured $\frac{1}{923}$rd of an inch, and the short diameter $\frac{1}{1500}$th. More than half a century after Hewson's discovery of their large size in the Skate, Professor Rudolph Wagner was, I believe, the first to show the largeness of these corpuscles in the other Plagiostomes. My measurements, long since published, are to the same effect; so that, as regards size, these corpuscles have, in contradistinction to those of Teleostei, a batrachian character, but are not so large as the same corpuscles in *Lepidosiren*. And now the measurements of the blood-disks of the great Shark show them to be so nearly alike in magnitude to those of the small dog-fish and other Selachii as to support my former observations, that in one and the same family of fishes and reptiles there is little, if any, relation between the size of the blood-disks and the size of the species. And this is just the reverse of the fact established by my old measurements, and others since made ('Proc. Zool. Soc.,' Feb. 10th, 1870), of the blood-disks of birds and mammals, showing that in many

orders or families of these two classes there is such relation, for in them the largest red corpuscles occur in the large species and the smallest red corpuscles in the small species. Of the blood-disks of Plagiostomi I hope soon to give a collected view of my measurements.

A Note *of some* Circumstances Affecting *the* Value *of* Glycerine *in* Microscopy. By W. M. Ord, M.B., Assistant-Physician to, and Lecturer on Physiology at, St. Thomas's Hospital.

Glycerine being very generally used in the making and keeping of many kinds of microscopic preparations, it is of some importance to be aware that in certain cases the action of this fluid is more than a simple penetration, more than an illustration of osmose. When, for example, the enamel of teeth is found after long stay in glycerine to have so far departed from original flinty hardness that it can be cut by a sharp knife, the exertion of either a solvent or a disintegrant power by the glycerine is suggested. Everybody knows that glycerine, even when pure and free from acid is a solvent of many substances (such as carbonate of lime; see Carpenter, 'The Microscope,' p. 220). But, perhaps, everybody does not know what glycerine is capable of doing in the way of changing the molecular arrangement of many other substances, and of altering their consistence. It may help to set people thinking on this point, if I quote a few instances from my own observations.

Trying, a few years ago, to preserve murexide in various media for microscopic observation, I found it altered by glycerine in a very remarkable way. After two or three days of contact with glycerine, the flat prisms of the murexide were, so to speak, eaten away at their sides till only long ragged pieces like badly picked bones remained. But what the prisms had lost had not disappeared. The field of observation was crowded with spherical tufts of fine radiating needles. In some tufts the needles were packed with almost the closenesss of the pile of velvet; in others they were longer and scantier, so that their aggregations closely resembled the starry tufts of black needles sometimes observed in melanotic deposits. It appeared to me at the time that this curious change was effected by alternate processes of slow

solution and precipitation. In later experiments, when the murexide was treated with very strong, slightly acid, glycerine, the crystals altogether disappeared after a few weeks, and were replaced by small spherical beads of a purplish-brown colour, very far short in their total bulk of the original bulk of the murexide. The little bodies were very uniform in size (about $\frac{1}{2500}$th inch); were sometimes perfect spheres, sometimes intermediate in form between spheres and dumb-bells; were of considerable opacity; and exerted no influence on polarised light.

At the end of a year these bodies are quite unaltered, and I have just compared them with murexide put up at the same time in Canada balsam, and still perfect as when first preserved.

On another occasion some crystals of oxalate of lime showing transition from the octohedral to the tetrahedral form were put up, some in Deane's medium, some in glycerine jelly, some in Canada balsam. In a few weeks the crystals in the glycerine jelly were all broken up, and their place was occupied by irregular masses of granular matter, and by dumb-bells and other sub-spherical bodies. The crystals in the Deane's medium, at that time still perfect, followed suit during the next few months, and at the end of three years the balsam also was found to contain no crystals, a few dumb-bells being scattered among formless matter. Here what was effected by the other media in months or years was for glycerine the work of only a few weeks.

More recently I have tried to turn this transforming power of glycerine to definite use, and have seen it in several instances intensify the power of colloids to break down crystals and mould their substance into spheres. Triple phosphate, for example, resists the action of such a colloid as gelatine, in so far that, while it rarely takes the "house-top" form, it on the other hand goes no nearer the sphere than to be gathered into large lumps of irregularly radiating stalactitic crystals, still perfectly sharp at their points and edges. Glycerine being added, much smaller aggregations are produced—either spherical, two-lobed or grape-bunch-like bodies with strongly marked internal fibrous radiation, or tufts of radiating spicules of uniform length; and with these are mixed some of the stalactitic lumps with their edges rounded and lost.

With such evidence of the alterative power of glycerine before us, it is impossible not to feel some misgivings as to the results of its use in the preparation of tissues for the microscope. Dr. Beale, who has probably used glycerine more effectively than any other observer, has shown me

nerve-preparations which after twelve years' keeping in glycerine are unaltered. But this fact does not render impossible the occurrence of a primary change disturbing the molecules from their original inter-relation before observation commenced. At the present moment, I do not intend to assert that such changes do actually occur, nor do I intend at present to take up the explanation of the phenomena here related. Both points. however, are worthy of the notice of microscopists, as affecting the character of a valuable reagent.

On REMAK'S CILIATED VESICLES *and* CORNEOUS FILAMENTS *of the* PERITONEUM *of the* FROG. By Dr. E. KLEIN, Assistant-Professor at the Brown Institution Laboratory.

REMAK describes (Müller's 'Archiv,' 1841, p. 451) in the mesogastrium of the frog, especially in the neighbourhood of the pancreas, parasitic formations, $\frac{1}{70}$th–1 line in length, $\frac{1}{300}$th–$\frac{1}{18}$th line in thickness, of cylindrical shape, of solid consistence, and varying in colour from a clear to a dark brown. It is but seldom that they end in a point at either extremity; in most part they appear transversely truncated. Most of them are enclosed in the tissue of the mesentery, only a few projecting above the surface. They lie either in groups, crossing each other irregularly with microscopic vesicular cavities or larger filaments, are so embedded, that they are fixed with their two extremities in two perfectly different cysts, formed of concentric layers of "cell fibres," while their middle portion exhibits no special envelope, or also, on its part, possesses a similar layer of cell fibres as a covering, which gradually pass into the fibres of the two ends. Very often, according to Remak, such (dumb-bell) shaped bodies are connected with each other like a chain, or it sometimes happens that several dark filaments lie in a single such dumb-bell shaped body. Most of the corneous filaments (as these filaments are described by Remak) exhibit abundant short lateral thorn-shaped outgrowths; only a few are smooth superficially. Remak proceeds to say, that he once had an opportunity of convincing himself upon a pale yellow transparent corneous filament, one line in length, that it consisted of a bundle of hollow fibrillæ united with each other in the direction of their length.

In the same contribution (p. 447) Remak describes clear vesicles of a spherical or oval shape, which occur on the mesogastrium of frogs of all ages and sizes. They are in most cases elevated above the surface, are of various sizes, from $\frac{1}{50}$th to $\frac{1}{4}$th of a line. Surrounded by concentric layers of knotted (embryonal) fibre-cells, the vesicles contain various bodies of a parasitic nature, which are in rotation. The internal surface of the vesicles is lined by cilia. Remak could not ascertain how these ciliated vesicles are formed: the smallest of them also contain no foreign body whatever in their interior. Remak, indeed, could not certainly persuade himself whether they were covered with cilia. Remak further considered it probable that there is a proliferation of the ciliated vesicles by segmentation. From the circumstance that the contents of many vesicles move in very various planes, Remak concludes that there are delicate partitions in the interior of the ciliated vesicles. The formation of these partitions seems to Remak to pass possibly for the commencement of the segmentation.

Remak considers these ciliated vesicles as well as the coverings of the corneous filaments, as cysts which contain parasitic bodies, and stand in a special relation to the development of the same.

Female frogs sometimes suffer from chronic peritonitis in the winter season, and that sometimes severe in intensity, sometimes less so. The changes which take place here will not be minutely discussed in this place. This constitutes a part of the investigation undertaken by Professor Burdon Sanderson and myself on the chronic inflammation of serous membranes in general, a report of which will very shortly be published. About the corneous filaments and ciliated vesicles described by Remak, I shall permit myself to make a few remarks only, and these adapted to make the statements of Remak complete.

If we open the abdominal cavity of a female *esculenta* which has been previously decapitated, we find, in some cases, on the mesogastrium (which, after the fashion of the omentum of many mammals, is fenestrated), or on the peritoneal covering of the stomach, on the mesentery of the intestine, and partly on the peritoneal coat of the intestine as well, certain structures which, to the naked eye, bear a resemblance to black hairs, and which look as if they were simply lying upon the parts just mentioned. However, as we may easily convince ourselves by using a forceps, they may be removed by pulling forcibly. If we bathe the structures referred to in a solution of gold or of silver, we perceive, even with the unassisted eye,

that they are not naked, but surrounded by a membranous covering which blends with the peritoneum.

If we excise the mesentery of the stomach in the fresh state, and mount it in a small drop of aqueous humour or blood serum, or if we colour it in a ½ per cent. solution of nitrate of silver and mount it in glycerine, these structures present a middle portion—a hair-like body—the corneous filament of Remak, and a sacculus. The corneous filament represents a dark spear-shaped body 0·89 to 1·5 mm. long, 0·021 mm. broad at the middle part and 0·03 mm. at the base. It comes to a point at the one extremity, and at the other is abruptly truncated. This body is not always broadest at the truncated extremity; there are not a few that are broadest in the middle. Some of them appear dark yellowish-brown at the truncated extremity. In this case there is also something like a fibrillar structure to be recognised, and it appears, as well, as if fibres penetrated from the covering into this truncated extremity. It has not occurred to me to notice a combination of distinct hollow fibres. The sacculus in which these bodies are imbedded is, in most cases, but not in all, raised above the peritoneal surface, to which it is then either connected by one or two thin bridges only; or, on the other hand, fastened for a greater extent. At times, two sacculi are connected by means of a bridge, being likewise joined to the peritoneum by a thin bridge only. In every case the sacculus has a complicated structure. On the large and complete formations we observe first the hair-like bodies surrounded by a wider or narrower layer of a substance containing coarse granular structures. This most internal layer of the sacculus is, chiefly at the truncated extremity only, but in some cases also at the portion which corresponds to the pointed extremity of the hair-like body, thickened in a bulb-like fashion. Outside of this follows a membrane, hyaline in profile, and double contoured, which towards the bulbus increases considerably in thickness, and here seems to possess staff-shaped nuclei. External to this membrane there are always, according to the thickness of the sacculus, sometimes more, sometimes less numerous, layers of cells, which, when seen in profile, appear spindle-shaped. In each of these a rod-shaped nucleus is to be recognised. The cells are imbedded in a fibrous matrix, and on the bulbus are more strikingly lamellated than on another place.

In many cases there lie in the bulbus, within those just mentioned, young cells which are compactly pressed together, and consist of a pale protoplasm. In other isolated parts of the sacculus we find smaller isolated groups of young cells

in the outer layers. Sometimes in the whole length of the bulb, within an external sheath of spindle-like cells, we recognise small compactly crowded young cells only. I have also seen some sacculi in which the hair-shaped body was wanting. These, however, were oval, and did not by any means present the appearance of cysts, as described by Remak; others I have seen in which this body was double. There occur also sacculi in which no distinct lamellation is present. In these cases the sacculus presents only a thick wall consisting of a connective-tissue matrix, in which spindle-looking cells may be observed. Finally, there are hair-shaped bodies with but one extremity imbedded in a sacculus raised free above the surface.

The sacculus is covered with an endothelium, which is unusually thick and large, and clearly granular; the cells possess either a simple clear nucleus, with a distinct nucleolus, or the nucleus is in the act of dividing or is double. In short, we have before us a condition which we ought to designate a morbid change of the endothelium. The endothelium supports on some sacculi, for the greater part of the surface, delicate cilia. With the structures described there are connected larger and smaller bud-shaped knots, on which either ciliated endothelium only is to be observed, or this covers a transparent matrix, in which are contained, more or less abundantly, young cells; or else the knot consists only of young cells covered with ciliated endothelium. In fresh preparations, mounted in serum, the movement of the cilia is exceedingly lively; but on other extensive portions of the surface of the membrane a similar ciliated endothelium may be discovered, as well as knots similar to those just described. The signification of these knots, and the history of their development, as well as that of the hair-shaped structures, we pass over here, as this does not belong to the plan of this communication. This much only we shall remark, that the sacculi of the hair-shaped bodies have nothing to do with cysts in a common sense, but, as will be shown in another place, stand in closer relation with chronic inflammation, having their complete analogies in certain chronic inflammations in mammals.

If we examine a fresh preparation of this kind with a No. 7 or 8 Hartnack, and survey more minutely the cellular elements which occur *in* the tissue of the sacculus, or *in* one of the knots described, or also *in* the tissue of the membrane, we shall discover some element or other in which is to be seen a clear circular spot, like a cavity filled with fluid. The cell presents nothing striking in size, its nucleus is situated

excentrically. In the cavity just mentioned we remark a lively movement, as if on the wall of the hollow a number of small granules were in rapid motion in a certain direction. If we inspect this more closely, we become aware that the appearance is due to nothing else than the uncommonly rapid movement of fine short cilia. But this is not all we can discover on our preparation. We find other spherical elements in the tissue which are rather larger than (about twice the size of) those just described. In them also we may perceive a cavity, just as much larger, in which the cilia projecting into it may be seen even with greater ease. Further, we find globular structures, about four times as large, enclosing a vacuole, which is not inferior in size to the lumen of a large microscopic blood-vessel. In the smaller ones the vacuole is bordered by a thin layer of a granular protoplasm, in which we may observe at one spot a nucleus undergoing division. Towards the outside this protoplasm appears bordered by a delicate hyaline membrane. The cilia which project into the vacuole are seen with extraordinary clearness; their motion is just as rapid as that in the superficial endothelial cells.

This movement of the cilia I have found quite as lively after the specimen had been mounted for four hours in serum.

In the interior of the vacuoles we see also one or two young cells, with one or more nuclei, as well as several smaller and larger granules, kept in rotation by the ciliary motion. The most interesting appearance I have seen in this way was the following. On one of the above-mentioned hair-shaped structures, found on the border of the preparation, there hung freely from the surface a knot covered with what might almost be called cubical endothelium, furnished with cilia moving in a lively manner. In the middle of the knot lay a large cell with a large vacuole. Within the vacuole there was also lively ciliary motion. From a vessel, which was to be found to the right of this, there were welled out blood corpuscles in numbers (from the pressure of the covering glass). These had scarcely escaped when they were swiftly chased away towards the left, in a semicircle, by the movement of the ciliated endothelium of the knot. In the vacuole of the cell which lay in the knot, there were two somewhat differently sized spherical cells; these were chased round in a direction from left to right. If now I adjusted the preparation, so that I could see at once both the border of the knot and the vacuole, I was witness of a most extraordinary spectacle—in the one place, the blood-corpuscles driven in

a curve from right to left, while further inwards the two cells were propelled in a circle from left to right.

But there is still another variety of similar cells, containing vacuoles, which may be observed. These are distinguished from the former by this peculiarity, that the wall which edges the vacuole possesses at individual spots smaller and larger knobs, which consist of a granular protoplasm and contain an oblong nucleus. These knobs themselves, again, have the appearance of being, in some places, in the act of division; at least, one finds them occupied by a groove, involving them more or less deeply. Or, on the other hand, the protoplasmatic wall exhibits, instead of these cells, oblong nuclei at regular intervals, corresponding with each of which the wall is thicker and projects into the vacuole, so that in profile an appearance is produced as if the vacuole were bordered by a layer of thin spindle-shaped cells fused at their extremities. Externally there appears to be here also a clear hyaline membrane. On vacuole cells so completely formed we can further determine another fact, viz. that the border limiting the vacuole does not support cilia in its whole extent. The more distinctly the vacuole appears lined with separate cells—that is, the more the wall has been differentiated into separate cells—the more seldom do we find cilia everywhere. We find only here and there separate cilia, or a bunch consisting of a few cilia. The cilia are also thicker, and appear to be shorter as well.

On the other hand I must, however, mention that I once found vacuoles coming up to 0·35 mm. in diameter, whose border was completely covered with cilia. These occurred on the mesogastrium of a female *Rana temporaria*, which presented no striking abnormality beyond very abundant vacuoles of the most various size, lined with cilia.

It was here, too, that I was able to discover among those well-known lymph sinuses which accompany the great blood-vessels of the mesentery of the frog (compare Stricker's 'Handbook,' chapter xxvii) one whose endothelium was also everywhere ciliated. This sinus, spherical in shape, 0·3 mm. in diameter, sharply bordered, and containing no formed constituents I could see with the greatest certainty communicating with the free surface by means of a stomatous opening not larger than a colourless blood-corpuscle. The stoma was lined with ciliated, yet cubical, cells. In the sinus the ciliary movement went on everywhere with great liveliness.

In individual specimens I find, like Remak, large vesicles, in which foreign bodies of the most various kinds are con-

tained, parasites, crystals, and granular masses varying much in size and form. Sometimes they are present in such numbers that the vesicles are filled with them. In other cases a part only of the interior is thus filled.

From what has been above adduced it is, therefore, clear that vesicular structures which are covered with cilia in a certain stage—not, indeed, standing in direct relation to their size—are developed in the same way that I have described in the endothelial vesicles of the growing blood-vessels of the embryo chick. ('*Sitzungsberichte der Wiener K. Academie d. Wissenschaften,*' *Part for March,* 1871.)

As regards the nature of these vesicles, we must, in the first place, pronounce them to be sinuses belonging to the lymphatic vessels; and, in the second place, we must say that a portion of them are there present from the first, and become covered with ciliated endothelium, it may be only under pathological conditions. They may, also under pathological conditions, contain parasites and other foreign bodies. Another portion of the vesicles is a new formation.

What was said about the mesogastrium applies in a similar, but more restricted sense, to the mesentery and to the septum of the *Cisterna lymphatica magna.* In regard to the last mentioned, I wish further to remark, that the ciliated endothelium known to Dogiel and Schweigger-Seidel ('*Berichte aus dem physiologischen Institute zu Leipzig,*' 1866), which in the normal condition is to be found there but sparingly, is in our case extensively distributed. Indeed, in some tracts of great extent nothing but such can be found. In some places it appears to be especially connected with the stomata perforating the membrane made known to us by the researches of these authors; that is to say, there is a thick wall bordering and lining the stomata, composed of endothelial cells bearing cilia, of cubical shape, and in a state of proliferation. Let us remark here, by the way only, that the description which Dogiel and Schweigger-Seidel have given of the structures bordering the stomata and the canals which traverse the membrane, is, in the strictly normal condition, applicable to small parts only; for they do not, in general, appear as discontinuities between the flat endothelial cells of the peritoneal surface, on the one side, and that of the cisterna lymphatica magna on the other—into which (discontinuities) the nuclei of the flat endothelial cells, which border them, project. They represent, on the other hand, canals which are, in most cases, lined with a special layer of small young cubical endothelial cells, supporting cilia.

On other places, on the contrary, the ciliated endothelium is also to be met with on the surface between the stomata extensively distributed in the form of trabeculæ and knots of proliferating ciliated endothelial cells raised above the surface.

On the STRUCTURE *of the* STEM *of the* SCREW PINE. By W. T. THISELTON DYER, B.A., B.Sc., Professor of Botany, Royal College of Science for Ireland. (With Plate V.)

SPECIES of the genus *Pandanus*, or screw pines proper, are a conspicuous element in the vegetation of the East Indian islands. Representatives of them are to be found in all large collections of tropical plants; yet, notwithstanding this, the few notices of their structure to be met with in books are meagre and incomplete in the extreme.

Looking at the anatomy of their vegetative organs, screw pines belong to the same type of arborescent monocotyledons as *Yucca* and *Dracæna*. These differ from single-stemmed palms in producing a crown of branches which increases in size and complexity as long as the plant lives. Under these circumstances it is evidently a mechanical necessity that there should be some provision for the enlargement of the primary stem of the plant, so as to afford an adequate support for the increasing weight of structures which it has to uphold. In palms the single stem has to bear little more than its own weight, and as it tapers upwards each successive increment of growth to the extremity probably adds less to the burden than the increment which preceded it. But it is quite otherwise when the primary stem breaks up into branches; each of these continues to divide, the number of growing extremities is multiplied, and every successive addition to the weight of the whole crown adds a heavier load than the last.

The fact that, at any rate, *Dracæna* possesses a provision for continuous additions to the circumference of the stem has long been known. This, independently of others, is a sufficient reason for abandoning the use of the term *Endogens* to describe monocotyledons; such a stem as *Dracæna* possesses is as much exogenous as that of an oak. Millardet[1] has carefully studied the circumferential growth both of *Dracæna* and *Yucca*; he finds that new fibrous bundles make their appearance in a cambium layer immediately exterior to the mass of original bundles, which undergoes itself no alteration. In

[1] 'Mém. de la Soc. Imp. d. Sc. Nat. d. Cherbourg,' 2e sér., i, pp. 319—352.

dicotyledons, as is well known, it is in the fibro-vascular bundles themselves of the original woody cylinder that the growth takes place. Stems of the *Dracæna* type so far simulate the woody structure of dicotyledons that the secondary woody growths are arranged more or less in concentric zones, but these growths are altogether independent of the mass of primary bundles. Millardet points out a further distinction in the two cases, in the fact that while the cambial cells in dicotyledons gradually undergo conversion into cells of the particular tissue, whether woody, bast, or vascular, they are destined to add to, in *Dracæna* the new histological elements are fashioned from cells which are produced secondarily by the repeated division of those of particular portions of the cambium layer.

In monocotyledons generally the fibro-vascular bundles which at their upper extremities pass into the leaves, at their lower terminate obliquely upon the surface of the stem, and are not, therefore, continued through the whole length of the plant's axis. It was originally supposed that the new bundles above mentioned in *Dracæna* were downward prolongations, subsequently formed, of the primary bundles. This was, in effect, a kind of reminiscence of the old, and now finally dismissed, theory of the descending formation of wood. Millardet, in tracing carefully the development of these secondary bundles, has shown that they have no connection with the original bundles of the stem, and, unlike these, are not inflected inwards towards its axial line, although they are not always free from lateral inclination.

In consequence of the death of a large and aged screw pine in the Botanic Gardens at Glasnevin from the attacks of a parasitic fungus, which had recently destroyed a similar plant at Breslau, I obtained this year a portion of the extremity of one of the branches in a fresh state. After seeing what had been made out by Millardet in the case of *Dracæna* and *Yucca*, I was in hopes that I might be able to trace similar facts in *Pandanus*. As, however, it was wished to attempt to preserve the stem of the plant in a dried state as a museum specimen, I was unable to get any of the older parts to compare with the younger. In the portion I examined I could not satisfy myself thoroughly of the existence of a cambium layer. In the youngest stems, which increase in this way, it does not make its appearance, and this might be the reason of my not finding it in *Pandanus*. There were, however, several points of considerable interest in the minute structure, and these appear to me worth description, though only contributions towards a more complete account.

The screw pines derive their name from the arrangement of the leaves in three close spirals at the extremities of the branches. As the leaves fall off below, they leave narrow, almost annular scars upon the stem, closely approximated together, and dotted with the cicatrices of the vascular bundles. The exterior of the stem is, in other respects, smooth, and covered with a very thin, rather corky rind, composed of rows of tabular cells, the outermost filled with very opaque incrusting matter. The general parenchyma of the stem does not appear, at any rate in the stems of the age which I examined, to become indurated, but remains succulent. The walls of the cells, though thin, were slightly thickened, and were evidently furnished with rather large "pores." The form which the cells take rather depends upon their position; as is also the case in palms, the cells are manifestly compressed when they are situated between two of the bundles. In this position they are really homologous with the compressed parenchyma of a "medullary ray." The most external portion of the parenchyma, abutting on the tabular cells of the rind, appears to retain its vitality, and the cells contain sparingly chlorophyll-corpuscles.

A transverse section of a stem about an inch and a half in diameter shows a sharply defined cortical region about two lines broad, in which the bundles are destitute of ducts and are exceedingly attenuated. Within this region, on the contrary, the bundles are crowded together very closely, and are very conspicuous. It might be supposed that this so-called cortical region is, in reality, the result of such a circumferential growth as has been described in *Dracæna.* But the fibrous bundles which it contains appear to me to terminate obliquely in the rind, and not to run parallel to it, as they would do in the former case. Perhaps these bundles are identical with the evascular bundles which Millardet describes in *Dracæna* under the name of "peripheral," distinguishing them from those connected with the leaves, which he calls "axile." They pursue a much straighter course than these last, and are developed later. Millardet believes that they will be found in all monocotyledons.

The areas of the fibro-vascular bundles in a transverse section increase regularly in size, proceeding inwards. The bundles consist of a mass of liber cells externally, of the usual elongated form; internally there is a much smaller mass, consisting of vessels or ducts and cells shorter than the external liber cells, with oblique and sometimes quite horizontally truncate ends. Mohl has described these, in palms, as wood-cells. They are marked with distinct pores, and in

Pandanus, contrary to the usual arrangement in monocotyledons, their walls are decidedly thicker than those of the liber cells. By transmitted light they have a yellowish colour, and collectively they give, viewed with a low power, a darker aspect to the inner portion of each bundle. The wood-cells in the centre of the bundle are often twice as large as the rest in diameter; possibly they may correspond to the "vasa propria" of Mohl. After repeated search I have failed to see anything in the *interior* of the bundles which could be properly described either as vasa propria or cambiform cells.

The vessels which are surrounded by the wood-cells consist of two large scalariform ducts, each of which is sometimes replaced by two smaller ones, presenting an appearance as if it had been divided by a transverse septum. Like all scalariform ducts, these are angular in section; but the angles are not parallel to the axis of the duct, and appear to me, in many cases, to wind spirally round it. Ducts with scalariform markings are often stated to be characteristic of the vascular cryptogams. This is not strictly the case. Sachs[1] figures them in *Ricinus;* Professor Dickson[2] has observed them in *Smilax*; they occur also in the tissues of, at any rate, fossil *Cycadeæ*.[3] A few spiral vessels, much smaller in diameter than the scalariform, occur on their inner side.

The inner side of the bundles is, as generally the case, wedge-shaped. In the screw pine it, however, appears frequently to happen that the bundles are reversed, so that the liber is turned towards the centre of the stem. When this is the case it seems generally also to happen that there is more or less complete fusion of two adjacent bundles. More rarely even three are combined in this way—and the resultant effect is very curious—the united bundles having a triangular section with the ducts at each of the angles. I have met with no other stem in which there is any arrangement like this.

The most remarkable feature, however, in the bundles, is the occurrence, at regular intervals round their periphery, of strings of small parenchymatous cells, each of which contains an oblong prismatic crystal. In a transverse section the internal reflection of light within the crystals makes the cells containing them appear almost black under a low power. The curious aspect given to the margins of the

[1] 'Lehrbuch d. Bot.,' 2nd ed., p. 94.
[2] 'Proc. Dub. Mic. Club.,' vol. i, 193.
[3] Carruthers, 'Trans. Linn. Soc.,' xxvi, p. 697.

bundles in consequence is shown in fig. 3 in the plate accompanying this paper. The strings of crystal-bearing cells are relatively most abundant in the peripheral bundles. They are always confined to the exterior of the bundles, and do not occur elsewhere in the stems. Under the microscope the crystal-bearing cells are a very conspicuous feature in a longitudinal section, especially when it happens to graze the surface of the bundles tangentially. Cells in linear strings, somewhat similar, only without crystals, and usually not isolated, occur in the *interior* of monocotyledonous fibro-vascular bundles, and would then be termed cambiform. The outside of the bundles appears to be a very anomalous position for them; indeed, I know of no similar instance of such an arrangement, and the presence of a crystal in each cell makes it still more remarkable.

The crystal-bearing cells being grouped in strings, which run parallel with the bundles, seems to indicate that the crystallizable matter is either conveyed directly or in its constituents more readily along their course than in any other direction. Sachs has shown that the fibro-vascular bundles in the active parts of plants have, when fresh, an alkaline reaction, while the adjacent parenchyma is acid. This alkaline reaction is connected, as is supposed, with the transport through them of nitrogenous protoplasmic matters. Cambiform cells seem always to take an active part in such transmission. One may, perhaps, hazard the theory that in *Pandanus* the cambiform cells occur on the exterior instead of the interior of the bundles. They are, therefore, especially liable, as their proper functions draw to an end, to the invasion of the acid fluids of the general parenchyma; crystalline salts are, consequently, formed from the mixture of these fluids with their basic contents. It can hardly be supposed that the end and object of the cells is to hold the crystals. It seems more reasonable to think, on the contrary, that the formation of crystals commences only when the original functions of the cells are beginning to cease. It should be remarked, in connection with this, that their walls are clearly thickened, and almost adhere to the contained crystals, but they do not seem to have any pores.

Crystals of an oblong prismatic form do not occur except in connection with the bundles in any of the tissues of *Pandanus;* as, however, noticed by Gulliver,[1] raphides abound in the leaves and "bark." I have found them plentifully dispersed in the general parenchyma of the stem, though in greatest abundance nearest the rind. They are

[1] 'Ann. and Mag. Nat. Hist.,' v. xiii, 293; v. xvi, 333.

contained in bundles of large ovoid cells. In a thin transverse section the openings of these cells catch the eye at once, both from their size and from the surrounding cells being arranged round each of them in the form of a rosette. It is rather difficult to see why the deposition of crystalline matter should determine the enlargement of the containing cells. It seems decidedly a physical as contrasted with a vital process, and there appears to be no reason why one cell should be the seat of it more than another. More mineral matter, probably, passes into the plant in the water taken up by the roots than it is able to use up in combination with cellulose in the construction and thickening of cell-walls. Some of this superfluity, united with organic acids, is deposited, probably in the first instance accidentally, amongst the contents of a not yet inert cell. Then, as the process of deposition will continue after once beginning, the cell is obliged to enlarge in order to supply the same space as before for its other contents.

The occurrence in the tissues of *Pandanus* of crystalline forms of two kinds is remarkable, but not quite a solitary instance. In the leaves of *Buonapartea juncea* Gulliver[1] has found a profusion of bundles of raphides, and also of "single four-sided prisms, flattened at the ends like a mason's chisel."

Although the screw pines are allied to the palms, according to Mohl neither raphides or other crystals are found in the plants of that family. On the other hand, in the family of the *Iridaceæ*, which are not nearly related, Gulliver finds prismatic crystals dispersed in the parenchyma to occur more frequently than in any other.

I am inclined to think that the presence or absence of raphides or other crystalline bodies in plants depends rather upon the texture of their tissues than upon their affinities. Soft or succulent tissues appear to be favorable to the occurrence of raphides, though the rule is not without exception.

As to the constitution of the prismatic crystals in *Pandanus*, I can make no definite statement, inasmuch as the extreme minuteness of the crystals and the difficulty of isolating them from their containing cells makes it all but impossible to test them in any way. I think, however, that there is little doubt that they consist of calcium oxalate. According to Sachs, this is the usual material of the crystals found in the cells of plants. In the four-sided prismatic form it crystallizes with six molecules of water, while in raphides only two molecules are present.

[1] 'Ann. and Mag. Nat. Hist.,' v. xiii, 408.

On STUDENTS' MICROSCOPES. By J. F. PAYNE, M.B., B.Sc.

THE regulations of the College of Surgeons, now coming into force, which require all medical students to become practically acquainted with histology, and are giving so great an impulse to this study in England, will impose upon many students the necessity of providing themselves with a microscope, and upon many teachers the responsibility of aiding their choice. It is with the view of assisting both classes that we have compiled the information contained in the following table. It is constructed entirely from data obligingly furnished us by the makers themselves, who are, therefore, solely responsible for the correctness of the statements made therein.[1] We do not, furthermore, undertake to recommend any one of these instruments,[2] but no makers' names have been admitted into the list except those of good repute; while the materials for a comparison are given by the table itself.

We may perhaps, however, do a real service to the student or beginner by pointing out what is the special importance of each point in microscopical construction, on which we have collected information.

1. *Height.*—The size of a microscope is not a matter of very great moment, and the convenience of a large or small instrument depends in great measure upon the height of the table, the seat, and so forth. But a small and portable microscope often has advantages over a more ponderous one, and the student of moderate means need not envy the possessor of a magnificent and sumptuous instrument. Length of tube, however, be it remembered, increases, *cæteris paribus*, the magnifying power.

2. *Diameter of tube.*—The advantage of a large tube is that it gives, speaking generally, a larger field, but this difference may be equalised by variation in the depth of the eye-pieces or in the length of the tube.

3. *Coarse adjustment.*—Practically there are but two forms of this mechanism—the rack-work, with milled head, used in England, and the sliding tube, working by friction, which is almost universal on the Continent. The latter is capable of quite as delicate movement as the former, or even more deli-

[1] Some makers, English and foreign, to whom we addressed a circular on this subject, have not responded to it.

[2] Valuable information and advice on these subjects, with figures, is contained in Prof. M. Foster's 'Report on Modern Microscopes,' published by Hardwicke, Piccadilly, 1867.

cate, but a person accustomed to a rack movement finds the other awkward, and is apt to do harm with it. The tube movement requires, of course, less workmanship, and therefore diminishes the price, or ought to do so.

4. *Fine adjustment.*—This is always effected by a screw with a very fine thread, usually acting against a spring. It is sometimes made to move the body of the instrument, sometimes the tube, and sometimes merely the piece containing the objective. The latter arrangement, acting by means of a lever, is probably the best, and is found on most English microscopes.

5. *Stage.*—This part of the instrument varies exceedingly, and is susceptible of almost any degree of complexity. If the microscope is used vertically little or no mechanism is necessary, but in the oblique position some arrangement for holding the slide and permitting restrained motion becomes indispensable. We do not pretend to decide what is the best means of attaining these ends, but for the comfort of those to whom simplicity is a matter of necessity we may express an individual opinion that an elaborate mechanical stage, besides being by no means necessary, is far from being an unmixed advantage. The tube under the stage, for receiving additional apparatus, which is almost peculiar to English microscopes, is decidedly useful. Any arrangement for securing the slide above ought to be removable at will.

6. *Mirror.*—The additional expense of giving a double mirror, one plane the other concave, is so very slight that no student's microscope ought, we think, to be without this convenience. The mirror ought, if possible, to have lateral movement, as well as universal movement in the axis of the microscope, for the purpose of getting good oblique illumination.

7. *Eye-pieces.*—Of these little need be said, since the amount of magnifying power desirable in them depends upon what the objectives will bear. But a very high eye-piece may be occasionally most useful, though not convenient to work with as a general rule.

8. *Objectives.*—These are, it need hardly be said, the most important parts of the whole instrument, and with thoroughly good objectives the character of other parts is only of subordinate importance, while nothing can make up for inferiority in this respect. Moreover, this is just the part in which it is worth while to spend money, since it is not lost either in mere display or in mere saving of trouble. The principal questions, however, which the student has to consider are what power is necessary for his purpose, and what objectives,

English or foreign, are the best. It is usual to furnish students' microscopes with nothing beyond a 1-4th, but we quite agree with Prof. Michael Foster's opinion, expressed in his 'Report on Modern Microscopes,' that it is very desirable for students, if possible, to have something higher. The extra expense of a $\frac{1}{5}$th, or even an $\frac{1}{8}$th, is not thrown away. As to the description of glass, there can be no question as to the excellence of the objectives made by the great English makers, whom we need not name, but their workmanship is rather expensive. With the exception of the latter point, the same may be said of the best French object-glasses, such as those of Hartnack. They are decidedly cheap, and yet it would be difficult or impossible to find any inferiority in their optical performance, as compared with that of the best and most costly English glasses of corresponding power. They have, however, two or three practical inconveniences. In the first place, the distance of the lens from the object is in the higher powers (from $\frac{1}{8}$th upwards) inconveniently small; and, in the second place, none but the immersion lenses are usually furnished with a correction for thickness of covering glass. We have separated Hartnack from other Continental makers, and this is partly on account of his incontestable reputation, partly because we can speak of his instruments from personal knowledge, but it should be said that many good judges place some other French and German glasses in the same rank, and we do not wish even to suggest that others may not be equally good. At the same time, judging from some of the specimens sold in London with the names of noted Berlin makers, the workmanship of the latter cannot be so uniform. Regarded as a matter of economy, then, the best foreign glasses are a good investment; but so many inferior glasses are imported, especially from Germany, that German high powers should, if possible, not be bought, otherwise than from the makers, without trial or examination or else a guarantee. The same precautions are, however, much to be recommended in purchasing any objective whatever. The question of object-glasses does not stand quite alone, for, though the different parts of the instrument may be obtained from different makers, it is generally expected that some objectives, at least, will be taken with a stand, and some makers will not sell separate objectives except at an increased price.

Now, as to the relative advantages of English and foreign microscopes, taken as a whole, we do not pretend to express an opinion, but we may state some of the reasons urged on both sides. In favour of an English microscope it is said that

you can always add to it extra apparatus which you may require, while it is awkward or impossible to send for this from abroad, and much of it is, in fact, not made there, since in the matters of stage management and illumination the English makers are decidedly ahead. Moreover, the student may desire to use his microscope a little for amusement and field natural history as well as for histological work, and then will want apparatus which is of little use in pure histology. Finally, some authorities, as Professor Michael Foster, find the English construction "in every way better and more comfortable to work with;" but this is, it must be admitted, a matter of taste. On the other hand, the admirers of the foreign microscopes say that, while the optical part, which is the chief matter, is so good, the stand and other parts only need to be adequate to their end. That for those who use a microscope as they use their anatomical scalpels or surgical instruments for pure work, the simplest stand is not only sufficient but preferable, since the less needless complication you have the better. Also there are persons who, as a matter of taste, find the French construction much more comfortable to work with, and the present writer can assert, as a matter of fact, that at least one possessor of two microscopes, a large and stately English instrument, and a small French model, will be found nine times out of ten using the latter. However, as there is one English maker who has constructed a precise reproduction of Hartnack's most popular model, it is possible to judge for one's self.

9. *Accessory apparatus.*—The most valuable additions that can be made to a microscope are, first, some contrivance for measuring, and, secondly, some contrivance for drawing. For the first an eye-piece micrometer is the best, but it is rather expensive. For the second, either a camera lucida or some form of reflector, such as Dr. Beale's. Beside these, to aid in illumination, a condensing lens for opaque objects should always be added; and an achromatic or some other form of condenser for transparent objects in artificial light is certainly an acquisition greatly to be desired. Polarizing apparatus and many other pieces of mechanism made by the opticians have a very restricted application in histological work.

10. One word must be said, in conclusion, on *price.* We have supposed that a sum of from five to ten pounds is as much as a medical student will be able, and need be called upon, to pay.

Name of Maker.	Name or description of instrument.	Total height from table when using high power.	Diameter of tube.	Coarse adjustment.	Fine adjustment.	Stage.	Mirror.	Eye-pieces	Objectives.	Range of magnifying power.	Accessory apparatus.	Price, with case.
C. Baker, 244, High Holborn, London	Medical student's microscope	16 in.	1¼ in.	Rack and pinion	Micrometer screw	Slide holder, with clips; universal movement	Single concave	2	Three, 1½ in., 1 in., ⅛ in.; of German make, selected and guaranteed	Diam. 40 to 500	None	£5 10*s*.
R. & J. Beck, 31, Cornhill, London	Popular microscope	15 in.	1¼ in.	Rack work	A fine adjustment	Sliding and rotating movement	Ditto	2	Two, 1 in. and ¼ inch; of own make	55 to 350	Side condensing lens on stand	£10
C. Collins, 157, Great Portland Street, London	No. IV	14 in.	1¼ in.	Ditto	Milled head with screw	Sliding movement	Ditto	1	Ditto	75 to 350	None	£5 5*s*.
Ditto	No. VI	16 in.	1¼ in.	Ditto	Ditto	Ditto, with universal movement	Double, flat, and concave, with all adjustments.	1	Ditto	85 to 390	Condensing lens for opaque objects, wheel of diaphragms	£6 10*s*.
H. Crouch, 51, London Wall, London	Student's microscope	15½ in.	1·4 in.	Ditto	Fine screw with lever	Movable object-carrier secured by springs	Double, with lateral movement	2	Two, 1 in. and ¼ in.	50 to 500	Stand condensing lens	£8 10*s*., or £10 with ⅛ in. and glass rotating concentric stage
Ditto	French model	12 in.	·95 in.	Sliding tube	Direct acting fine screw	Movable springs	Single concave	2	Two, 1 in. and ⅛ in.	50 to 450	Condensing lens	£7

James How, 2, Foster Lane, London, E.C.	Student's microscope	15 in.	$1\frac{3}{8}$ in.	Rack work	A fine adjustment	Universal motion plate secured by springs	Single	1	1 combination of 1 in. & $\frac{1}{4}$ in.	—	Condensing lens on stand	£6
Murray & Heath, 69, Jermyn Street, London, S.W.	Ditto	15 in.	$1\frac{1}{16}$ in.	Chain movement	None	Sliding movement	Ditto	1	Two, 1 in. of 15°, $\frac{1}{4}$ in. of 75°	60 to 310	None	£5 17*s.* 6*d.*
Ditto	Ditto, No. II	$15\frac{1}{2}$ in.	$1\frac{1}{16}$ in.	Rack work	Fine screw	Universal movement by springs	Double	1	Two, 1 in. of 15°, $\frac{1}{4}$ in. of 75°	Ditto	Ditto	£7 19*s.* 6*d.*
J. Parkes & Son, 5, St. Mary's Row, Birmingham	Educational or medical microscope, No. 1909	$15\frac{1}{2}$ in.	$1\frac{3}{16}$ in.	Ditto	Fine screw with lever	Magnetic	Ditto	2	Three, 2 in. and 1 in. (combination), $\frac{1}{4}$ in.	20 to 350	Stage condenser	£5 5*s.* (Binocular, £7 10*s.*)
Ditto	Ten-guinea microscope	18 in.	—	Ditto	Ditto	Mechanical	Ditto	2	Ditto	Ditto	Sliding stand condenser, wheel of diaphragms	£10 10*s.*
M. Pillischer, 88, New Bond Street, London	Prize microscope	12 in.	1 in.	Ditto	None	Improved 'lever' stage	Single concave	1	Combination giving a 1 in. and a $\frac{1}{4}$ in.	40 to 300	None	£5
T. Ross & Co., 7, Wigmore Street, London	No. III	$16\frac{1}{2}$ in.	$1\frac{3}{16}$ in.	Ditto	Ditto	Sliding stage	Double, with jointed arm	1	One of 1 in.	37	Condensing lens on stand, animalcule cage	£10 (without case)
J. H. Steward, 406, Strand, London	Medical student's microscope	15 in.	$1\frac{3}{16}$ in.	Ditto	Fine screw with lever	Top spring plate	Double, with extra joint in arm	2	Two, 1 in. of 15°, $\frac{1}{4}$ in. of 75°	55 to 180	Diaphragm, live cage, condensing lens on stand	£8 15*s.*
E. Wheeler, 48, Tollington Road, Holloway, London	Educational	$14\frac{3}{4}$ in.	$1\frac{3}{16}$ in.	Ditto	Ditto	Fixed springs or sliding plate	Single concave	1	Two, 1 in. of 16°, $\frac{1}{4}$ in. of 70°	40 to 200	Condensing lens on stand	£5 5*s.* (Mechanical stage 25*s.* extra)

*Foreign Microscopes.**

Name of Maker.	Name or description of instrument.	Total height from table when using high power.	Diameter of tube.	Coarse adjustment.	Fine adjustment.	Stage.	Mirror.	Eye-pieces	Objectives.	Range of magnifying power.	Accessory apparatus.	Price, with case.
E. Gundlach, Charlottenburg, near Berlin	Student's microscope	13 in.	$1\frac{1}{8}$ in.	Sliding tube	Fine screw moving without friction	Plain stage	Double	2	Two, $\frac{1}{2}$ in. and $\frac{1}{7}$ in.	70 to 500	None	46 thalers =£6 18*s.*
E. Hartnack et Ce., 21, Place Dauphine, Paris, and Potsdam, near Berlin.	No. VIII [Horse-shoe stand.]	About 10 in.	About $\frac{7}{8}$ in.	Ditto	Fine screw moving the body	Ditto	Double, with lateral movement	3	Two, $\frac{1}{2}$ in. and $\frac{1}{8}$ in.	70 to 450	Ditto	240 francs =£9 12*s.*
Ditto	No. III A	Ditto	Ditto	Ditto	Ditto	Ditto	Single	2	Two, $\frac{2}{3}$ in. and $\frac{1}{6}$ in. (smaller angle than those above)	50 to 480	Ditto	155 francs =£6 4*s.*
G. & S. Merz (formerly Fraunhofer), Munich	No. VIII (known as Professor Donders's)	—	—	Rack work	Micrometer screw	—	Double, with lateral movement	4	Two, $\frac{1}{3}$ in. and $\frac{1}{18}$ in.	8 to 720	—	56 thalers =£8 8*s.*
Wasserlein, 27, Schützen Strasse, Berlin	A [Horse-shoe stand.]	9 in.	About 1 in.	Sliding tube	Micrometer screw and spring	Fixed springs; revolving stage	Ditto, ditto	3	Four, about $\frac{1}{2}$ in., $\frac{1}{4}$ in., $\frac{1}{6}$ in., $\frac{1}{12}$ in.	20 to 800	Eye-piece micrometer divided in 0·1 mm.	£7 10*s.*
Ditto	A 1 Ditto	8 in.	Ditto	Ditto	Ditto	Plain stage	Ditto, ditto	3	Three, about $\frac{1}{3}$ in., $\frac{1}{5}$ in., $\frac{1}{8}$ in.	45 to 600	Ditto	£4 10*s.*
C. Zeiss, Jena	[Horse-shoe stand.]	About 12 in.	Ditto	Ditto	Fine screw	Stage with springs	Ditto, ditto	3	Two, either 1 in. or $\frac{1}{2}$ in., and $\frac{1}{4}$ or $\frac{1}{8}$ in.	75 to 740	A good camera lucida	61 thalers = £9 3*s.*, carriage free.
											[One guinea less without camera lucida.]	

* The prices include an arrangement for inclining the body of the microscope at any angle.

REVIEWS.

A Monograph *of the* Gymnoblastic *or* Tubularian Hydroids. Part I. By Geo. J. Allman, M.D., F.R.S.E.

Although, generally speaking, it is better to await the completion of a work before it is reviewed, it is impossible, in the present instance, not to welcome the appearance, though only in part, of Professor Allman's long and anxiously looked for Monograph on the Hydroida. In one sense, moreover, the present part of the monograph may be regarded as an independent work, seeing that it is entirely devoted to the consideration of the life history of the Hydroida, or their "general morphological or physiological relations as a great natural group," whilst the second part will be devoted more especially to the consideration of the Tubularinæ, including a description in detail of all the genera and species of which that subdivision is composed.

The entire monograph therefore will embrace "a purely descriptive "zoology of the Tubularinæ, combined with a careful study of their structure and physiology, and of the structure and physiology of the entire order of the Hydroida," without which it is obvious that the meaning of many things in the economy of the Tubularinæ would have been left very obscure.

Treated in this way, the life history of almost any natural group of animals may be made in the highest degree conducive to the advancement of philosophical zoology and physiology, for, as is well remarked by the author, "when thus investigated, it will be found that the study of the Hydroida possesses an interest far beyond what one may at first be inclined to attribute to beings so simple in their structure, and so apparently insignificant in the place allotted to them in the economy of nature, for we shall then learn that some of the most important facts in morphology and some of the highest laws in physiology find in them their expression and elucidation."

The term *Hydroida*, as employed by Professor Allman, includes the *Hydrinæ*, *Tubularinæ*, *Campanularinæ*, and *Sertularinæ*, which families constitute the hydroida of Dr. G.

Johnston; but, in addition to these, the term as now understood, necessarily includes most, if not all, of the so-called naked-eyed or gymnophthalmic medusæ, whose relation to the fixed forms was unknown to the distinguished author of 'British Zoophytes.' The term, therefore, is uuderstood in the same sense as it is by Mr. Hincks in his excellent 'History of British Hydroid Zoophytes.'

Professor Allman commences his work with a very full account of the history of the progress of our knowledge of the Hydroida, but which, for reasons given, is in great measure confined to the more important steps which have been made towards the determination of their systematic position, and their recognition as a distinct group. In this exhaustive chapter much interesting matter will be found, not only in an historical point of view, but as conveying, in the account of the conflicting notions of various observers, very important information respecting the morphology and physiology of the Hydrozoa in general.

The next chapter is devoted to the morphology of the hydroids and the explanation of the terminology adopted by Professor Allman, which will, it is to be hoped, receive universal acceptation; for, when thoroughly comprehended, the terms employed will serve at once to convey a clear and precise notion of the nature and morphological significance of the multitudinous elements which enter, at one stage or another, into the complicated life history of a hydroid.

In the main, the terminology corresponds with that employed by Mr. Hincks, but with many additions, serving to render descriptions more precise and intelligible.

The sense, moreover, in which some of the terms are employed differs slightly from that usually attached to them. As, for instance, Dr. Allman assigns the following characters as distinguishing a "zooid" from an "organ" (a distinction, as he observes, which it is not in all cases very easy to make). "A zooid," he says, "is a more or less individualised animal organism, which may or may not be capable of independent existence, and which constitutes one of a series whose members are related to each other by some form of non-sexual reproduction, and morphologically repeat one another either actually or homologically."

"In this sense," he continues, "not only are the free medusiform buds of the hydroida true *zooids*, but we must also regard as such the fixed hydranths and those fixed gonophores which never attain a developed medusiform structure, as well as the single generative sacs which are developed in the radiating canals of Obelia, Thaumantias, &c.

This is, no doubt, the true view of the case, though the last instance given may appear, at first sight, a little staggering.

The morphology of the hydroïda is considered under these two heads: 1st, of that of the *trophosome*, or collection of nutritive zooids, or the *hydranths*, and the stem upon which thy are seated—the *hydrophyton*; and, 2nd, of the *gonosome*, or aggregate of reproductive zooids (gonophores), &c. These zooids may remain permanently attached to the rest of the hydrosome, or may become free; for which latter class, represented by the naked-eyed medusæ, the author proposes the general appellation of *planoblasts*, or "wandering buds." Some of these, however, although presenting all the essential characters of a free medusiform zooid, may remain attached to the parent zooid during the whole of their existence.

But these planoplasts are nevertheless themselves distinguishable into two distinct kinds, in one of which the generative elements are directly produced—*true gonophores*—or indirectly, "through the intervention of another bud which is developed from them." For the latter form of what may be termed non-sexual gonophores, the designation of *blastocheme* is employed, whilst the proper sexual medusiform *planoblast* is designated a *gonocheme*.

As "the gonosome is that part of the hydroid which presents the most marked variation among the different membeis of the group," the study of the various forms it presents "possesses for tha morphological student a profound significance."

The author, consequently, enters upon a detailed examination of the various modifications of the gonosome, in the most exhaustive manner, whilst his descriptions of the complicated structures concerned are illustrated with an abundance of excellent woodcuts, the whole constituting the most complete and most intelligible account of this difficult subject anywhere to be found, and bringing our knowledge of it, in every particular, up to the latest period.

The same may be said of the next chapter—on development; but space will not allow us here to give even a superficial account of these most interesting portions of Dr. Allman's labours, and we shall merely cite the two fundamental propositions to which the study of the development of the hydroids has led:

"1. The fixed plant-like hydroida give origin to sexual buds not only in the form of closed sacs, which develope within them the generative elements; but also in that of a more specialised form of bud which becomes a free (rarely fixed) medusa, which ultimately attains, either directly

(gonocheme) or indirectly (blastocheme), to sexual maturity, and produces ova or spermatozoa.

"2. The ova of the medusiform bud undergo, like those of the sporosac, a continuous development, by which they become transformed into hydriform trophosomes, while these trophosomes ultimately give origin, by buds, to medusæ identical with those from whose ova the trophosome was directly developed."

The fifth chapter is devoted to the histology of the hydroida, and in it will be found much of the greatest interest to the microscopical observer, who cannot, when the opportunities of observing these animals, and more especially the medusiform gonophores, offer themselves, employ his instrument to greater advantage than in the study of their minute structure, several points in which appear to us, notwithstanding what has been done by so many able observers, still to demand further investigation, more particularly with high powers.

In the case of the medusæ the transparency of the tissues, while alive, is so great as to afford the utmost facilities to the skilful manipulator, and they present a further advantage in their persistent vitality, which renders it possible to observe the structure, for instance, of living muscular fibre, under conditions of compression and disintegration, which in almost all other cases would deprive it of vitality; and the importance of being able to examine tissues in the living condition is becoming daily more and more obvious.

The histological points, as it appears to us, which more especially require further investigation, are: 1. The real structure of the gelatiniform substance which makes up so much of the thickness of the disc. 2. The real conformation of the muscular tissue. 3. The still more important question as to the existence or not of a nervous system.

1. With respect to the first of these points Professor Allman says, that he has failed in his attempts to detect any structure in the gelatinous portion of the umbrella in the naked-eyed medusæ; and it must be acknowledged that, speaking generally, no obvious structure can be detected in this substance in that class. Nevertheless, as analogy would lead us to suppose, that it must resemble the same tissue in the Steganophthalmata, in which, as long since shown by Schultze, a sort of cellular structure is discernible; and also since it was shown by Mr. Busk,[1] in 1842, in *Turris neglecta*, that the gelatiniform substance, at any rate, at the base and walls of the stomach, is distinctly cellular, it is a question well worthy of investigation, whether an analogous condition

[1] 'Trans. Mic. Soc. Lond.,' 1842. Vol. III.

may not in reality be more extensively present than is commonly supposed.

2. With regard to the muscular or motile fibrillæ, notwithstanding what has been done, some conflict of opinion still appears to exist, This may, perhaps, in part arise from there being two kinds of fibrillated contractile tissue in the hydroida, viz. that noticed by Professor Allman (p. 112), and described as consisting of tubular fibres, about $\frac{1}{3000}$th of an inch in diameter, smooth and nucleated, and often presenting the aspect of fusiform cells, and so far not unlike the involuntary muscular fibre of higher animals, which form of contractile fibres would seem to be present more especially in the tentacles and bodies of certain *hydranths*. And besides this, another form of fibrillated tissue, apparently widely different from the above, found in the umbrella and velum of the medusidæ, consisting, as stated by the author (p. 114), of fibres having a diameter of not more than $\frac{1}{10,000}$th inch, and resolvable under a high power into a single series of corpuscles," and thus presenting a marked resemblance to the ultimate fibrillæ of striated muscle, spread out so as to form a broad membranous expansion. This is the only kind of muscular tissue that has fallen under our own observation, although the distinctness of the striation varies much in different cases.

3. The presence or absence of a distinct nervous system is also a point with respect to which we still are very much in want of definite knowledge.

The existence of such a system in the *Beroidæ* seems to have been tolerably satisfactorily made out. What has been so regarded in the steganophthalmatous medusæ is, as it seems to us, of extremely doubtful nature. And although many excellent observers, and especially Haeckel, one of the latest who has written on this subject, appear to have arrived at the conclusion that traces of such a system are observable in the gymnophthalmata, the question can by no means be regarded as finally settled.

In the last chapter of the present Part we have a general account of the process, or rather processes, of reproduction in the hydroida; but into this subject we have at present no space to enter further.

In conclusion, we must congratulate the Ray Society that such a work as the present should have been brought out under their auspices. As regards the beauty and fidelity of the figures it is impossible to speak too highly, and the admirable way in which the plates have been executed is beyond all praise. The work, when completed, will mark an epoch not only in the history of the Ray Society, but in the zoological literature of Europe.

NOTES AND MEMORANDA.

Important Correction.—Dr. E. L. Moss writes to us as follows:

"A printer's error in page 404 of last volume makes me speak of the *in*accuracy of Professor Gegenbaur's plates; the context fortunately indicates the mistake to some extent—the word should have been 'accuracy'—but a definite correction is due rather to myself than to Professor Gegenbaur, whose figures are well-known models of diagramatic accuracy, and whose reputation is uninfluenced by my praise or censure.

"Edward L. Moss, M.D., R.N."

New Microscopical Journal.—We learn from the 'American Naturalist' that the State Microscopical Society of Illinois has issued a prospectus of 'The Lens, a Quarterly Journal of Microscopy and the Allied Natural Sciences; with the Transactions of the State Microscopical Society of Illinois.' It will be an octavo, each number containing at least forty-eight pages of reading matter. Terms, two dollars per annum in advance. The editor will be Mr. S. A. Briggs, 177, Calumet Avenue, Chicago. Though its appearance has been delayed by the fire, we learn that it will soon be issued.

The Brown Institution.—This important institution for the study of the diseases of animals, endowed with funds left in trust to the University of London, is now fairly started at a very suitable locality in the Wandsworth-road. It contains a laboratory for the study of histology and pathology, under the direction of Dr. Klein.

The Spectrum Microscope.—Mr. Sorby, in an article entitled "On the best Form of Compound Prism for the Spectrum Microscope" published in 'Nature,' Oct. 26th, 1871, discusses the amount of dispersion desirable for particular purposes:

"It would be a very great mistake to suppose that the result is better with a very wide dispersion. This, of course, makes the spectrum larger, but very greatly impairs the definition of the absorption-bands."

"The power ought to be regulated by the character

of the absorption-bands. If they are dark, narrow, well-defined, and lie close together, as in the case of partially opaque crystalline blow-pipe beads of borax containing deposited crystals of oxide of lanthanum with oxide of didymium, a somewhat powerful dispersion is not only admissible, but quite necessary to separate some of the bands. If, however, they are broad and faint like those seen in the spectra of many of the colouring matters found in animals and plants, a powerful dispersion spreads them over such a wide space, and makes the shading off so gradual, that the eye can scarcely appreciate the extra amount of absorption; whereas, when a lower dispersive power is used, a well-marked absorption-band can easily be seen."

"There can be no doubt that it is a great advantage to have a number of prisms of different dispersive power, so that in all cases the most suitable may be used; but at the same time some observers might not wish to have more than one, and thus it becomes important to decide what amount of dispersion is the best for the generality of objects—is sufficiently great to divide narrow, closely-placed bands, and yet not so great as to prevent our seeing broad and fainter. No magnifying power whatever is applied to the spectrum itself in the instrument now under consideration."

Mr. Sorby then goes on, "As described in some of my former papers,[1] the compound, direct-vision prisms first made for me by Mr. Browning were composed of two rectangular prisms of not very dense flint-glass, and three of crown glass, one being rectangular, and the other of an angle of about 75°. This combination gives a dispersive power which shows faint bands very well, but is not enough to divide the narrow and close bands seen in the spectra of a few substances. Mr. Browning then made prisms of similar construction, only that very dense flint glass was employed. This combination gives about double the former dispersion, which divides narrow and close bands admirably, but sometimes shows broad and fainter bands so very badly that they can scarcely be recognised. It thus appeared to me that, if only one compound prism be supplied with the instrument, the best dispersive power would be intermediate between these two extremes. At the same time much would depend on the particular purpose to which the instrument was applied, and also, to some extent, on the individual differences between different observers.

[1] 'Popular Science Review, vol. v., 1866, pp. 66—77; 'Brit. As. Report,' 1865 (pt. 2), p. 11.

"Mr. Browning has described[1] the plan that he proposes for the measurement of the position of absorption-bands by means of a bright line, seen by reflection from the surface of the prism, moved backwards and forwards by a micrometric screw with a graduated head. My objection to the original construction was that the bright line was photographed on a small piece of glass, and the background was so far from being black as to much impair the spectra of substances that will not transmit a bright light. I suggested that in place of this glass plate a small piece of tin-foil should be used, having a very minute hole in it. This shows far brighter than the line in the photograph, and the background is quite black; and thus the bright dot can easily be seen even when in the brightest part of the spectrum, and there is no extraneous light to impair the faintest absorption-bands. The only important objection to this method of measuring their position is, that a very slight movement in the apparatus, due to the loose fitting of movable parts, alters the readings, and that the value of the measurements, as read off by the micrometer, depends on so many variable particulars, that nearly every instrument might have a different scale. The chief objection to my interference scales[2] is the difficulty of making all agree absolutely, but when accurately made they have not the above-named disadvantages. I therefore still adhere to that plan, but at the same time I have found the bright dot arrangement very useful, not only as an indicator in showing spectra to others, but also as a fixed point in comparing different spectra, or in counting the bands of the interference scale. Possibly without such help some observers might find this difficnlt, and would prefer in all cases to measure the position of bands by means of the graduations on the circular head of the micrometer, and therefore I was anxious to devise a prism that would have a dispersive power intermediate between the two extremes already mentioned, and at the same time have the upper face inclined at an angle of 45° to the axis, so that the bright-dot micrometer might be employed conveniently. To accomplish this, Mr. Browning made for me a prism composed of two rectangulars of crown glass, one rectangular of very dense flint, and one of less dense, cut at such an angle as to give direct vision. This combination gives what I consider to be as good a medium dispersion as could be wished, and at the same time enables us to measure the position of the bands with the bright-dot

[1] 'Monthly Microscopical Journal,' vol. iii, p. 68.
[2] 'Proc. Roy. Soc.,' vol. xv, p. 434.

micrometer as accurately as is requisite in nearly all practical applications. Subsequent trials have shown that the same advantages may be secured in a more satisfactory manner by replacing the less dense flint glass prism by two, one of flint and the other of crown, of such angles as give direct vision for the whole combination of five. The dispersion is very nearly the same as that of two prisms of ordinary flint glass of 60° angle."

The Origin of Guano.—At a meeting of the Lyceum of Natural History, of New York, Dr. Habel gave an account of observations made in the Chincha Islands, which lead to the conclusion that guano is a stratified deposit. Professor Edwards concurred in this view, which, indeed, he had previously expressed in 1868. He writes:

"When the portions of guano, which are insoluble in water and acids, are examined by means of the microscope, it is found to be made up of the skeletons of Diatomaceæ, Polycystina, and Sponges, invariably of marine origin, and sometimes identical with those living in the adjoining ocean, and fossilised in the adjacent Infusorial strata. Also we find that some of these forms occur in patches exactly as they grow in nature, and as they would present themselves if they were deposited from water, and not as they would be if they had to pass first through the alimentary canals of mollusca and similar small animals, then through the same organs of fish and birds, in turn, as they would have to do, to get into the guano in the manner commonly supposed.

"From all of these facts and others that I have collected of no less importance, derived from chemical and microscopical characters, I have come to the conclusion that guano is not the excreta of birds deposited upon the islands and main land after its upheaval, but that it is the result of the accumulation of the bodies of animals and plants, for the most part minute and belonging to the group which Haeckel has included in a new kingdom, separate from the animal as well as the vegetable under the name of Protista, and subsequently upheaved from the bottom of the ocean. Subsequent chemical changes have transformed it into guano, or heat and pressure have so acted upon it that the organic matter has been transformed into bitumen, while the mineral constituents are preserved in the beautiful forms that make up the mass of the extensive "Infusorial" strata, found in various parts of the world."

It is also stated that the anchors of ships moored in the neighbourhood of the Chincha Islands constantly bring up guano from the bottom of the ocean.

Micro-Photography by direct Sunlight.—Mr. J. J. Woodward, of the United States' army, has directed his attention to the method of photographing histological preparations by direct sunlight. To avoid the inconveniences of direct solar rays it has been customary to pass them, for photographic purposes, through a screen of ground glass. Mr. Woodward finds that it is possible, by the use of a suitable condensing lens, to dispense entirely with the ground-glass screen, and thus greatly to diminish the time of exposure as well as to obtain superior sharpness of definition. His method is as follows:

"The microscope being placed on a shelf at the window of the dark room, and its body made horizontal, the achromatic condenser is illuminated by a solar pencil reflected from a heliostat upon a movable mirror outside the shutter, and thence into the dark room, precisely as described in my original paper upon micro-photography. No ground glass is used, but instead a lens mounted in a suitable tube is fixed in the opening of the shutter, through which the solar pencil enters. This lens is an achromatic combination about two inches in transverse diameter, and of about ten inches focal length. It is placed at such a distance from the achromatic condenser that the solar rays are brought to a focus, and begin again to diverge before they reach the lowest glass of the achromatic condenser.

"For anatomical preparations requiring for their display from two to five hundred diameters, I use an $\frac{1}{8}$th of an inch objective without an eyepiece, obtaining the precise power desired by variations in the distance of the sensitive plate from the stage of the instrument. I have lately given the preference to immersion objectives, the corrections of which, I find, are generally well suited to photographic requirements.

"Now with an $\frac{1}{8}$th objective, and the arrangement above described, the field is so brilliantly illuminated that the eye cannot safely be permitted to look down the tube. The image is therefore received upon a piece of white cardboard, and, sitting by the microscope to make the adjustment, I view the card with both eyes precisely as in the case of the ordinary solar microscope.

"With these arrangements, the cardboard, placed from two to four feet from the stage of the microscope, is sufficiently well illuminated to permit distinct vision, even when objectives of the shortest focus are used, and powers of five to ten thousand diameters obtained. While the object is thus seen on the white screen in its natural colours, the cover correc-

tions, focussing, management of the achromatic condenser, and selection of the portion of the preparation to be photographed are readily managed. When all is satisfactory, I insert an ammonio-sulphate cell between the large lens and the achromatic condenser, and draw down the velvet hood which prevents leakage of light from about the microscope into the dark room; then, going to the plate-holder, I make the final focussing in the usual way on the ground glass, or on plate glass with the help of a focussing glass, according to the nature of the object.

"With powers of five hundred diameters, or less, I at first experienced some difficulty in giving the right exposure; for as the time required was but a fraction of a second, it is a matter of some difficulty to regulate it with precision. At length I succeeded by arranging a sliding shutter, with a transverse slit of variable width, so adjusted as to fall with its own weight before the tube of the microscope, the exposure being made during the passage, and the time of exposure regulated by the width given to the slit.

"Of course it occurred to me that for such short exposure the heliostat might be dispensed with, and I found on trial without it that a large right-angled prism used in the position of total reflection, or even an ordinary mirror, gave excellent results; the exposures being even shorter than when the heliostat was used, since there was but a single reflection. I could not satisfy myself, however, that the quality of the pictures differed from those obtained with the help of the heliostat, except, perhaps, that in certain cases the prism seemed to offer advantages which will be referred to hereafter. Under these circumstances the heliostat appears desirable for ordinary use, since the solar pencil being thrown in a constant direction, the trouble of adjusting the illumination of a series of objects is considerably diminished; but I have convinced myself that equally good pictures, even with very high powers, may be produced without it, a circumstance of considerable interest where motives of economy preclude the microscopist from procuring this convenient instrument.

"The special device of placing the large condensing lens so as to bring the solar rays to a focus *before* passing through the achromatic condenser had been suggested many years before by the late Rev. J. B. Reade, as an improvement to the solar microscope, with the special object of preventing the concentration of heat rays and any consequent injury to the object."—('Silliman's American Journal,' October, 1871.)

Development of Algæ.—Professor A. M. Edwards has com-

municated to the Lyceum of Natural History (New York), some observations on this subject.

The plant he examined belonged to the genus *Œdogonium* of Link, but the particular species was undetermined. The perfect plant itself consists of an extremely fine, green-colored filament, cylindrical in form, and having its frond divided at regular intervals by partition walls, so that the individual plant may be represented by a series of tubular cells or boxes, like tall pill-boxes, united end to end.

"The mode of reproduction known to exist is (says Professor Edwards) by the shrinking inwards of the inner cell-membrane, commonly known as the 'Primordial Utricle' of Mohl, and enclosing the cell-contents, away from the tough cellulose coat, while at the same time the cell-contents themselves assume a more or less coarsely-granular condition, apparently from the enlargement of the individual particles of which it is made up. It is recorded that thereafter, at a certain period in this change, the outer cell-wall splits across at a point near to one end of the cell, and, while the lid so formed remains attached to one side the other and largest portion, the cell-contents escape from the cavity into the surrounding water, and gradually assume the spherical form. Thereafter there is developed upon one side of the sphere a ring of cilia which become more and more active until, at last, they move about with such energy that the little green globe assumes an extremely active motile condition. In this state it has been called a 'motile spore.'

"Up to this period our record, as hitherto published, is complete, but just here is a gap and it has been my good fortune to make such observations as fill it and complete our knowledge of the life history of this plant. The changes and transformations which I now record, I have seen not merely a few times, but perhaps, thirty or forty, so that I am enabled to speak confidently as to the accuracy of my notes, as I have watched the whole process. It is as follows. At first the bright green-coloured cell-contents, around and investing which I have not been able to satisfy myself that I have seen a 'Primordial utricle,' grow gradually coarser in texture by a process of differentiation of the mass in such a way that granules appear which increase in dimensions at the expense of the surrounding and investing substance, until the whole cell is filled with a coarsely granulated mass, differing little in colour from the original cell-contents. At the same time the whole green mass recedes somewhat from the enclosing cellulose wall, and instead of filling it completely withdraws itself in such a way that its outline, near the ends,

becomes rounded. Soon thereafter the cell-contents contract still more, moving towards one end of the cylindrical cell. Then, with a sudden snap, fracture takes place almost entirely across the tough cell-wall at a point about one twelfth of its length from one end, that is to say a portion measuring about one twelfth of the length of the whole cell splits across with a perfectly smooth and even fracture, still adhering by a very small portion, and looking like the lid to a box, is thrown back more or less so as to expose the transformed cell-contents to the surrounding fluid. But now the green cell-contents move towards the openings thus formed, and slowly and steadily push themselves outwards, and, being elastic, escape after the manner that a small elastic sac filled with semifluid contents would escape from the hand if pressure were brought steadily to bear upon it. But in this case the emergence is not caused by the closing in of the cell-wall, but by a motile power resident in the elastic sac and its contents. It is not shot forth suddenly from the cell-cavity, but squeezes itself out, and as soon as it has escaped assumes the form of a perfect sphere, and, as if exhausted by its previous exertions, comes to a rest. But, although the whole mass is not now in motion, the cell-contents do not remain at rest but go on to another change. The bright green, coarsely-granular sphere being at rest, is seen first to become somewhat clearer upon the surface, and evidently a process of differentiation goes on by means of which a very delicate investing membrane is formed, but it is so delicate that it can only with difficulty be seen; and, in fact, can hardly be seen to exist as a separate membrane. But upon one side is now seen to appear a bulging outwards of the mass until a nipple-like protuberance is formed which, however, is not filled with the green matter formed elsewhere, but is clear and colourless. Soon thereafter, there is seen to be a slight agitation going on upon the surface of the sphere, near to, and upon one side of the clear space. This movement then assumes a more definite character, and at last a moving cilium is seen to be formed or differentiated from the outermost portion of the globe. Soon another and another are formed in the same manner, attached by their bases around the clear space, and soon, that is to say in fifteen or twenty minutes, a ring of active cilia are seen to surround the nipple-like projection. As soon as they have all made their appearance immediately they all begin to move together and in a violent manner, so that motion is imparted to the whole mass, and it swims about actively through the water. Up to this point I find that these changes have been observed

and recorded by others. But now comes what I consider the most important part of this history.

"It can be readily understood that, on account of its violent action the further history of the spherical mass could not easily be followed, but fortunately on several occasions I saw specimens entangled in a mass of filaments in such a way that they could not escape from the field of view. Then I saw that the motion became gradually less and less vigorous and at the same time the cilia disappeared one by one, melting out of view, being apparently absorbed again into the mass from which they were originally developed. At the same time one of them seems to elongate until it is one to three times as long as the diameter of the spherical mass, and also, its point of attachment changes until we find it springing from the centre of the clear projection. While this is going on, the whole mass, not changing its position, assumes however a totally different outline. That is to say, the clear nipple-like blunt part remains about the same, but the opposite portion becomes pointed, while the intermediate space is inflate in such a way that the whole creature in outline somewhat resembles a trefoil clover. The inflated part, however, does not remain rigid, but soon subsides, while the clear end becomes more pointed, and now the creature is spindle-shaped in outline. As there is now but one cilium it is by means of it that the creature moves about in an extremely active manner. In some, and in fact in by far the most cases I observed, the swelling of the middle portion is not fixed but moves down the length of the creature towards what may with some propriety be termed the posterior extremity, as it is always projected backwards when it is moving through the water, and there disappears to be soon followed by another swelling and wave-like projection and so on. In fact, an action resembling very closely that seen to take place in the intestines of animals, and known as peristalsis, takes place. Many individuals move directly and straight onwards, preserving their body perfectly rigid, so that after a time the cell-contents are seen to arrange themselves in longitudinal bands. Others, again, revolve on their longest axes, and soon the cell-contents of these are seen to have arranged themselves in spiral lines corresponding to this movement. Some of these retain their straight condition, while others become bent around so as to form almost a complete circle, and then proceed onwards by a rolling motion. There is a regular and determined passage from one of these states to the other, as I was able to ascertain by careful watching; but the most remarkable fact connected with the

whole matter, is that all of these forms are precisely similar to creatures which have been ranked by Ehrenberg and others in the animal kingdom, under different names, but most commonly that of *Euglena*. To make the resemblance to the Euglenas still more marked, as soon as the circlet of cilia has disappeared, and the mass elongates, a bright red spot appears near the clear end, and usually also, one or more clear seeming vacuoles are seen to arise within the green mass. The red spot has been called an eye, and the vacuoles stomachs; and in this way Ehrenberg was enabled to classify these forms as 'Polygastric Animalcules.' The spirally twisted forms have been placed in a separate genus and in fact I have seen, in the way mentioned, developed from the cell-contents of a filament of Œdogonium forms identical with several genera of 'Polygastric Animalcules.' After a little longer time the cell-contents have again changed in appearance so as to be coarsely granular, each granule being so large and distinct that it can readily be distinguished, and now the active motion of the mass ceases, and it takes on the static condition. This it does by increasing in size, elongating and losing its cilium and red "eye" spot, while the clear portion elongates, sub-divides, and branches out and becomes fixed either to a full-grown filament of Œdogonium or some other submerged substance that may serve it as a support. Now the cell-contents become finely granular again, and arrange themselves against the cell-wall which is thickened considerably. Soon a bending in of an inner membrane, or 'Primordial Utricle' is seen to take place and cell-division after the well-known method occurs, until a filament is formed exactly like that from which the original green sphere was projected."

The points to which the author wishes to drawn special attention are the finding of the means by which the active spherical form is converted into the still state previous to growth into a filament; and, further, the identification of this phase with certain forms hitherto classed, sometimes in the vegetable, sometimes in the animal kingdom.

Books received.

'Jenäische Zeitschrift,' Bd. vi, Heft 4.

'The Microscopic Dictionary,' 3rd edition, Parts 1 and 2.

'Ueber die Nesselkapseln einiger Polypen und Quallen. Von Dr. Karl Möbius.

'Medizinische Jahrbücher,' red. von Stricker, Heft 3.

QUARTERLY CHRONICLE OF MICROSCOPICAL SCIENCE.*

HISTOLOGY.

I. **Text-books,' &c.**—The fifth and concluding part of 'Stricker's Histology' contains the following articles:—Continuation of 'The Organ of Hearing,' by Rüdinger and Waldeyer; 'The Olfactory Organ,' by Babuchin; 'The Retina,' by Max Schultze; other parts of the eye, by Iwanoff, Leber, Schwalbe, Babuchin, and Rollett; 'The Lachrymal Gland,' by Boll; 'The Uterus and Appendages,' by Chroback, Reitz, and Grünwald; and 'The Development of the Simple Tissues,' by Stricker.

Rindfleisch's 'Pathological Histology' is announced to appear in an English translation, under the auspices of the New Sydenham Society.

The new part of Henle's 'Anatomy' (vol. iii, part 2) contains "The Brain and Spinal Cord," giving very full histological as well as topographical descriptions.

II. **The Cell in général.**—Eimer, "On the Structure of the Cellular Nucleus" ('Schultze's Archiv,' viii, 141), finds the nucleolus in a large number of cells (skin, connective tissue, ganglion-cells, smooth muscle, fibre-cells, &c.) marked off from the rest of the nucleus by a ring of granules, external to which was usually a circular zone, paler than the rest of the nucleus.

III. **Blood.**—1. Manassein ('Centralblatt,' No. 44, Oct. 28th, 1871) gives the result of more than 40,000 measurements on 174 different animals, intended to show the effect of various physiological and morbid influences on the size of the red corpuscles. In general, influences which raise the temperature of the body were found to diminish the size of the corpuscles, such as very high temperature of the external medium, or septic poisoning. Excess of carbonic acid in the air also acts in the same way. Oxygen, on the other hand, increases the dimensions of the corpuscles, and

* The editors will be glad to receive, for the purpose of making this record more complete, copies of separate memoirs or reprints from periodicals, which must otherwise often escape notice.

so do, in general, all substances which depress the animal temperature, as external cold, quinine, hydrocyanic acid, and intoxicating doses of alcohol. Morphia is an exception, since, though it generally reduces animal temperature, the corpuscles become larger under its influence. Finally, acute anæmia (produced by arterial hæmorrhage) increases the dimensions of the corpuscles. A more detailed account is promised.

2. "Kerner on the White Blood-cells and their Alteration by Quinine." (Pfluger's 'Archiv,' vol. v. p. 27.)

IV. **Epithelium**—1. Robinski ('Reichert's Archiv,' 1871, p. 184) discusses the microscopical and microchemical relations of the so-called cement substance (*kittsubstanz*) of Recklinghausen and others, which has been supposed to exist between epithelial cells and other structures, on the ground of their behaviour with silver solutions. He denies the existence of this substance *in toto*.

2. Lott ('Centralblatt,' No. 27, Sept. 16th) gives a preliminary notice of researches on the structure and physiological regeneration of epithelium, especially that of the cornea.

3. The elaborate article of Ranvier on epithelium ('Nouveau Dictionnaire de Médecine et Chirurgie,' vol. xiii, p. 675) should not be omitted, though published last year.

V. **Connective Tissue and Fat.**—1. "The Structure and Development of Tissue," by F. Boll ('Schultze's Archiv,' vii, 276), including (1) tendon; (2) cartilage; (3) fibrillated connective tissue; (4) development of the same in the germinating hen's egg ('Sch. Arch.,' viii, 28). (The commencement of a long and laborious series of investigations.)

2. "Physiology of the Fat-cell," by W. Flemming ('Schultze's Archiv,' viii, p. 328). A continuation of his previous researches (see same vol., p. 32, 'Q. J. M. S.,' vol. xi, p. 295). He has now studied atrophy of fatty tissue and also its condition in inflammation. Discusses the differing views of Toldt.

3. Ranvier ('Comptes Rendus,' July 10th, 1871) has studied the morbid alterations of the loose connective (or cellular) tissue in œdema.

4. A paper on "The Structure of Tendon," by Lanzilotti-Buonsanti ('Sulla struttura dei tendini,' Milano, 1871) is referred to in 'Centralblatt,' No. 40, Sept. 30th, 1871.

5. Flemming ('Ueber Bindesubstanzen bei Mollusken,' Rostock, 1871; 'Centralblatt,' No. 41, Oct. 7th), describes the connective tissue of the mantle of the Lamellibranchiata. He finds it to be a very peculiar structure,

which may be generally characterised as an extremely complicated and ramified vascular cavity (*schlauch*), the wall of which possesses fixed cells, but no formed intercellular substance, and, further, many round cells (or mucus-cells) of peculiar character. This structure, which may be regarded as the typical connective tissue of mollusks, is modified in other parts of their organism into a more solid tissue by increase of the intercellular substance and of the fixed cells, while the vascular tubes acquire at the same time a distinct endothelial lining. Flemming has never observed true fibrillæ of connective tissue in any of the mollusks (Prosobranchiata and Lamellibranchiata) examined by him.

VI. Muscle.—Flögel ('Schultze's Archiv,' viii, 69) describes the striated muscle of a mite, genus Trombidium, and compares it with that of a crustacean (Cyclops), also with that of a cockchafer. He agrees with Krause as to the muscle-compartments or boxes, divided by transverse partitions, but differs from him and all other observers in some particulars. He worked with osmic acid, which is optically very advantageous.

VII. Nervous System.—1. Elin "The Minute Nerves of the Buccal Mucous Membrane." ('Schultze's Archiv,' vii, 382). Elin used the gold method with tartaric acid. Found medullated fibres, with a distinct nucleated sheath, passing into non-medullated fibres with intercalated nuclei, running mostly parallel to surface and united into a network in upper part of *mucosa*. From these very fine fibres enter papillæ and epithelium; those entering epithelium have granular varicosities and form an imperfect network. They are also connected with cellular bodies. Those which run to upper layers of epithelium return to the mucosa, looping round epithelial cells. In general, his observations agree with those of Klein, and also with those of Chrschtschonowicz on the mucous membrane of the vagina.

2. Jobert ('Journal de l'Anatomie,' vol. vii, p. 611, 1870-71) discusses the nerves of sensation in two researches, one on the tactile apparatus of the extremities of a Raccoon (*Procyon lotor*), another on the tactile apparatus of Gasteropoda. In the palmar surface of the digits of Procyon he found the corpuscles of Meissner, not previously observed except in man and the anthropoid apes, while in the deeper layers were found groups of Vater's corpuscles. Nerves terminate in both these bodies, which are very closely connected with the neurilemma, of which they may, so far as their non-nervous part is concerned, be regarded as a special development.

With regard to Gasteropoda, his conclusions are that in all of them the nerves contain myelin, and the same is true of the acephalous mollusks. The tentacular nerves of the Helicina break up near the periphery of the organ into fibrils presenting varicosities, and in their course cellular enlargements are observed, which are analogous to those observed in vertebrate embryos. These fibrils pass in bundles through the true skin and lose themselves in the epidermis, between the large epithelial cells, in the shape of filaments expanded at their extremity. A number of large cells are observed amongst and around the expansion of the tentacular nerve, which are nothing but secreting cells. The arrangement of nerves in the folds of the mouth, &c., is generally the same.

3. Chrschtschonovitsch ('Reports of the Imperial Academy of Vienna,' lxiii, 2nd Abth., 301—315, "Contributions to the knowledge of the minute nerves of the vaginal mucous membrane") used the gold method; he describes a subepithelial plexus, and non-medullated varicose fibres running among the epithelial cells. He could find no connection with the nuclei of the smooth muscular fibres, as described by some observers.

4. Fleischl ('Centralblatt,' No. 42, Oct. 14th, 1871) proposes a new method of investigating the *surface of the brain* under the pia mater. When this membrane is carefully removed, he puts the exposed surface of the convolution into a half-per-cent. solution of nitrate of silver, and after a few minutes into distilled water, by which the surface acquires a brownish-red colour. Then, by passing the edge of a cutting needle very gently over the surface, small fragments of a delicate film which covers the brain substance may be removed. These fragments, when examined in glycerine, show flat polygonal areas, closely apposed, and varying in size from that of a nucleolus to that of a leucocyte. Fleischl considers these areas to represent cells, but reserves a more detailed anatomical explanation for the present, calling the structure simply *cuticulum cerebri et cerebelli.*

5. Ranvier has communicated to the Société de Biologie in Paris the first results of some laborious researches on the minute structure of peripheric nerves, which are thought to throw a new light on their physiological action.

It is known that chemical changes take place during nerve function; the nerve substance becomes acid and heat is liberated. There must, then, be some osmotic exchange of liquid or gaseous matters, and the histological details appear to show how the exchange takes place.

The nerves employed are the long and slender thoracic nerves of the mouse. They are dipped in a solution of nitrate of silver (1 to 300), then washed in distilled water and examined in glycerine. The entire nerve, under a magnifying power of 150 diameters, shows very clear small transverse bars, which are cut at a number of points by another small vertical bar, so as to represent a number of Latin crosses. It may then be seen that the transverse limb of the cross corresponds to the axis-cylinder. If the nervous thread be dissected and treated with a neutral solution of picrocarminate of ammonia (1 in 100), the matter becomes very clear, and it is easy to make out that each little cross corresponds to a *strangulation*, near which the axis-cylinder appears of a faint yellow colour. It then becomes more and more distinct with the carmine coloration, expands, and becomes covered with drops of myeline, which is hardly or not at all coloured. With a power of 800 diameters the *strangulation* in question is seen to be caused by a true discoid ring, which acts there as a collar constricting the nerve-tube. In dissected preparations the rings as well as the axis-cylinder are coloured black by solution of nitrate of silver at the level of the strangulation. It hence follows that both the picrocarminate and the silver solution pass through the ring and reach the axile centre of the nervous cord. The conclusion is, in fact, that liquids can penetrate into the nerves, and that the curious arrangement observed by M. Ranvier constitutes the place where and, in a certain sense, the organ by which this penetration takes place.

Ranvier has been led to conclude that the nervous cord is enclosed in a true serous cavity with an epithelial lining.

[As previously stated by Stricker and others: see Dr. Klein's article in this number of the Journal, p. 21.—Ed.]—*Revue Scientifique.*

VIII. Organs of Sense.—1. Morano on the pigment layers of the retina ('Schultze's Archiv' viii, 81).

2. Reichert ('Reichert und Dubois Reymond's Archiv,' 1871) has completed his memoir on the labyrinth of the ear. ("Gehörschnecke.")

3. Dobrowolski ('Schultze's Archiv,' viii) describes "double cones" from the retina.

4. In another paper on the retina he discusses the ellipsoid or lenticular bodies of Krause and Schultze.

5. Schmid on the lymphatic follicles of the eye ('Die Lymphfollikel der Bindehaut des Auges.' Wien, 1871.) An exhaustive study of these structures, beautifully illustrated.

IX. Vascular System—The development of vessels in in-

flamed tissues has been studied by Carmalt and Stricker in the cornea. Among other things they describe appearances which suggest to them the possibility—first, that fixed tissue-cells may become permeable canals, and thus true vessels; and, secondly, that new cells, which develop into ordinary blood-corpuscles, are formed within the cells thus altered. This view of the new formation of blood elements outside the normal vessels, has (we need not say) always been held by Rokitansky, and by many English observers, but of late years has dropped out of sight.—(*Medizinische Jahrbücher*, 1871, 3rd part, p. 428.)

X. Digestive Organs and Glands.—Schwalbe ("On the Glands of the Intestines, especially the Glands of Brünner;" 'Schultze's Archiv,' viii, 92) has found in the duodenum of the rabbit, but not of other rodents, glands resembling the pancreas in structure, which he believes to be *not* the same as certain glands functionally resembling the pancreas described by Cl. Bernard from the duodenum. They are quite distinct from Brünner's glands; which also are very elaborately described. Some of their secreting elements are found to resemble the capital cells of Heidenhain from the gastric glands, while others are still more like the secreting cells of certain salivary glands and mucous glands of the mouth. The glands of Lieberkühn have an entirely different structure.

XI. Teeth.—'Contributions to the Histology and Pathology of the Tooth Pulp' is the title of a dissertation by Julius Bruck, published in Breslau.

XII. Urinary and Sexual Organs.—Löwenstein ("The Lymph-follicles of the Mucous Membrane of the Vagina," Centralblatt, No. 35, Sept. 2nd, 1871) shows that this mucous membrane is not destitute of such structures, as is generally asserted in anatomical text-books.

EMBRYOLOGY AND DEVELOPMENT.

Blood-vessels.—Klein; the middle germinal layer in its relations to the development of the earliest blood-vessels and blood-corpuscles in the embryo of the foal (with six plates). 'Reports of the Imperial Vienna Academy,' vol. lxiii, second division, March, 1871.

Oellacher ('Sch. Archiv,' viii, p. 1), contributions to the history of the germinal vesicle in the vertebrate ovum.

Skull.—'Essai sur l'Anatomie, &c., de la Voûte du Crâne;' thèse pour le doctorat. Par E. Le Courtois. Paris, 1871.

Mr. Parker's elaborate paper on the "Development of the Skull of the Common Frog," which, though not strictly histological, must not pass unnoticed here, has just been published *in extenso* in the 'Philosophical Transactions.'

PROCEEDINGS OF SOCIETIES.

Dublin Microscopical Club.

20th April, 1871.

Rev. E. O'Meara showed a specimen of *Striatella interrupta* found in a gathering made by him in Strangford Lough, near Newtownards, Co. Down. He considered it in all respects identical with the form described by Heiberg ('De Danske Diat.,' p. 73, t. v, fig. 15) under the name *Striatella interrupta*. He remarked that, while he agreed with that distinguished author in separating this form from *Striatella unipunctata*, he differed from his opinion that it is identical with *Tessella interrupta*, so vaguely described by Ehrenberg, and figured, not very accurately, by Kützing and Ralfs in "Pritchard." The two forms he considered quite distinct, and in corroboration of his view referred to some specimens of *Tessella interrupta* recently found *in situ*, on sea-weeds, collected many years ago by M'Calla in the County Galway, and now in the herbarium of Trinity College. While these forms agree in having the diaphragms alternately disposed, there was a marked difference in the structure of the diaphragms. In Striatella the diaphragms extend from one end of the frustule almost to the opposite end. In *S. unipunctata* these diaphragms are filled up only a very short distance from the point of insertion, and are hollow for the remainder of their course. In *S. interrupta* the diaphragms are filled up to the centre, and hollow from that out. The diaphragms in Tessella extend no further than the middle of the frustule, where they slightly overlap; they seem also projected from the margin at an angle greater than 90°, whereas in Striatella they are projected at right angles. Grunow, he added, identifies Tessella with Striatella; but considering the peculiarities indicated, as well as the general appearances of the valves, he felt disposed to regard Striatella and Tessella as distinct, though closely allied, genera.

Mr. Thiselton Dyer showed a section of the wood of, as he believed, an undescribed British fossil palm. The section was made from a rolled nodule belonging to Professor Church, of the Agricultural College at Cirencester, and which was picked up on the beach at Southwold, in Suffolk. It no doubt came from the coprolite bed of the Red Crag; but this was itself a littoral accumulation of the *débris* of older rocks, and the fossil palm wood, though found in a Pliocene deposit, was almost certainly of Eocene age. Similar nodules of that age have been found on the Sussex

coast. The wood is completely silicified, and the details of its structure are very perfectly preserved. From the even distribution of the fibro-vascular bundles the fragment must have formed part of a trunk of large size, and this was tolerably conclusive evidence of its having belonged to a palm. Mohl had, however, shown that the structure of palm stems could not be correlated with their other characters, so that here our information stopped. Unger had, indeed, based a genus Fasciculites upon fossil palms, in which the parenchyma was arranged in a somewhat radiate manner round the bundles, as is the case in the present specimen; but this was manifestly a valueless character, and Schimper had transferred all true palm stems to Palmacites.

Dr. R. McDonnell showed various epithelial structures, which he had prepared from the frog and other subjects, to illustrate the value of the nitrate of silver process in rendering the delicate cell-walls evident under the microscope, the nucleus becoming stained by the use of the carmine solution, thus rendering the histological features readily discernible.

Mr. Archer showed some conjugated examples of *Spirotænia truncata* (ejus), brought from Glencar, Co. Kerry, on a recent brief excursion in company with Dr. E. P. Wright. This minute species is a rare one in itself, and the zygospore had only once before been seen, and then first recorded by Mr. Archer, along with the then likewise first-known instance of the conjugation in its larger and far more common relative, *Spirotænia condensata* ('Quart. Journ. Micr. Science,' vol. vii, n. s., p. 186). Hence the present gathering, showing some dozen or two of examples of the conjugated state (in *S. truncata*), was of some interest. Mr. Archer regretted, however, he had been unable to detect any less advanced or earlier condition of the conjugative process in this species than that he had figured. In case, however, this state should be met with by others, he ought to mention that the figure of the zygospore published is unfortunately too stiff, and the angular lobe-like projections rather too symmetrical; they are, in fact, somewhat irregular, and less pointed at the apices; but the colour and general appearance, with the still appended empty parent cell-walls, are correct. These conical or sub-triangular projections seem to be void, of a straw colour, and the spore itself is a green orbicular body, posed in the centre of the general cavity. Such a special outer covering to the spore, the latter contracted into a smaller body in the centre of the cavity, leaving an interspace between it and the former, has a parallel in certain other species in Conjugatæ, *e.g. Docidium Ehrenbergii*, *Tetmemorus granulatus*, *Mougeotia glyptosperma* (de Bary), &c. The present species had never before been exhibited, with its zygospore, to the Club, and the latter forms a singular-looking and certainly pretty little object.

Amongst other of the rarer Desmidieæ taken on the same occasion (from Cos. Kerry and Cork) were presented examples of *Tetrachastrum pinnatifidum;* this is a very rare form, and, when

found, presenting itself exceedingly scantily. *Staurastrum elongatum* (Barker) was found very sparingly, though two years ago in the same situation, where Dr. Barker first met it, comparatively plentiful, though confined to a circumscribed area (since then, however, as previously recorded, Mr. Archer took it in Connemara). *Tetrachastrum oscitans* (Ralfs), Dixon, *Micrasterias Jenneri* (Ralfs), *Penium spirostriolatum* (Barker), *Staurastrum Pringsheimii* (Reinsch), *Pleurotænium* [*Docidium*] *nobile* (Richter), and several others less uncommon, were to be seen on the table; but the takings in this, or, indeed, any department, were on the whole, very poor, owing to the excessive rains and universally flooded condition of the best sites; very few zygospores seen.

Mr. Archer was, however, able to draw attention to the conjugated state taken at Glencar at same time, of *Navicula serians*, a very common diatom, but one seemingly but rarely met with in that condition. The present examples, as might be anticipated, presented no feature not already so correctly described by Mr. Carter in his valuable paper on the conjugation of this form ('Ann. Nat. Hist.,' vol. xv, 3rd ser., p. 161). In the main, too, it coincides with the conjugation of *Stauroneis phœnicenteron* (see 'Quart. Journ. Micr. Science,' vol. viii, n. s., p. 189); still, as an object, the present was very interesting to see, as the conjugated state in diatoms is so comparatively seldom encountered.

Mr. Archer likewise presented examples of a rather large form of Chlamydomonad, taken also at Glencar, Co. Kerry, showing a seemingly singular speciality; that is, instead of the flagella, here four in number, originating from one and the same place, they proceeded from four distinct and comparatively widely separated points at the anterior end, each flagellum starting from a circumscribed pale spot or region, as it were, of its own, like that single common one immediately at the end, at which, in allied forms, the usually two flagella co-originate. Thus, to a certain extent, one might look upon the present, as it were, as a form with four apices, or as four uniciliated individuals combined into one. Such a supposition, though assisting to realise an idea of the form in question, would not be tenable apparently, because each of these quadriciliated examples showed but one "eye speck;" this was deep crimson in colour, and lateral or parietal in position, and placed rather low down the elliptic "body" of this organism, seemingly lenticular in shape when seen at the extreme margin, and then appearing to produce a minute convexity somewhat projecting from the general curve of the outer contour. The general chlorophyll contents were brilliant green; outer "wall" colourless, hyaline, and often seeming to be faintly obliquely striate. The motion was vivid, and this form being rather large, and occurring in great quantities, formed a very pretty exhibition. This may, indeed, come very close to *Chlamydomonas multifilis* (Fresenius, in his memoir "Beiträge zur Kenntniss mikroskopischer Organismen," 1858, t. xi, f. 34, 35,

36), but that form, besides appearing to be much smaller, presents the four flagella emanating from one and the same point of origin at the apex of the body, and the "eye speck" appears to occupy a position more immersed in the contents, not, as it were, directly apposed to the outer coat, or, indeed, seemingly a little prominent beyond its contour; as to their identity or non-identity it would, however, appear premature to come to any direct conclusion; the form now shown had never before been detected by Mr. Archer, but it may, indeed, be not uncommon, and it is to be hoped that ere long it may be met with elsewhere, and its true nature determined.

As a companion exhibition, and interesting for the sake of comparison with the foregoing, Mr. Crowe brought forward examples of a more minute green biciliated form of Chlamydomonad, probably a state of "*Protococcus pluvialis*." These were taken in vast numbers from the hollow stone near the railway station at Bray, which in warm wet weather frequently yields an abundance; these, in the mass in the collecting bottle, presented a brilliant green, and when seen crowded under the microscope moved with amazing rapidity.

Dr. Moore brought to notice a similar yet distinct form to the foregoing, taken from a receptacle for growth of aquatics in the Botanic Garden; here the individuals were somewhat pointed at the opposite extremities of the still more minute, less brightly green, biciliated bodies, the motion active though ere long subsiding. Both this of Dr. Moore's as well as Mr. Crowe's were mutually distinct things, and each even still more distinct from that shown by Mr. Archer, yet all "related," no doubt, but all requiring much and long observation, and happy opportunities in the future, for their ultimate elucidation.

Amongst rare Rhizopoda found at Glencar, Mr. Archer drew attention to his *Diaphoropodon mobile* ('Quart. Journ. Micr. Sci.,' vol. ix, n. s., p. 394), as well as his more lately encountered *Amphizonella vestita* ('Quart. Journ. Micr. Science,' vol. xi, n. s., p. 107). It is a pity that in the figure published of the former rhizopod, either the artist or printer has imparted much too *blue* a colour to the processes fringing the general outline of the body; they are colourless, or nearly so—in fact, in a sketch, would be best represented by a mere line of weak gum water, with the faintest admixture of Indian ink and cobalt. In the present examples not any protococcoid cells seemed to have entered into the composition of the loosely-aggregated encasing of this form, but a greater number of minute diatoms contributed to the production of a kind of investment rather more dense than in the first examples Mr. Archer had ever seen (from Glen-ma-lur Valley, in Co. Wicklow); yet all foreign bodies were disposed in but a loose and "tossed" manner, but diatoms were always applied flatly to the body.surface. Mr. Archer thought this form must be justly regarded as amongst the extreme rarities; found only once before in a very restricted area (though at so great a

distance as Wicklow and Kerry), he had almost begun to think it lost to ken, and, indeed, it had only on the present occasion presented itself in a single gathering out of two or three dozen which had been taken at Glencar.—The examples of *Amphizonella vestita* observed were without chlorophyll-granules, but covered by more or less well-developed external hair-like processes; were pretty active, and possibly very slightly smaller in dimensions than those originally met with.

Amongst other rare Rhizopoda taken on same occasion there occurred examples of *Euglypha spinosa*, Carter ('Ann. Nat. Hist.,' 3rd ser., vol. xv, p. 290). This was the first time found in Ireland, and Mr. Archer was not aware of its having been met with by other than its original discoverer, Mr. Carter, nor by him in any new site. It is quite a striking form from its comparatively large size. A good opportunity presented itself to obtain a transverse view, as one specimen obligingly became tilted up "on edge," frontal opening downwards, and retained that position for a length of time. Its striking size, lenticular shape of the test, and long very bold spines fringing its *extreme* edge, its nearly elliptic outline in the broad view, and its wide, arched anterior opening, would seem to forbid this form being mistaken for any other Euglypha. So far as Mr. Archer knew, this was the second instance of its occurrence, and here it was very scanty.

18th May, 1871.

Rev. E. O'Meara showed some preparations from Diatomaceous material from Sulu Archipelago (north of Borneo), forwarded by Captain Chimmo, R.N., containing many rare forms of interest; one of these, new, Mr. O'Meara named *Navicula Chimmoana;* the material required working up, and he would revert to it on an early occasion.

Dr. E. Perceval Wright exhibited some mounted specimens of the calcareous bodies from the integument of *Cucumaria modesta*, Selenka. He had forwarded a collection of Holothuroids made at the Seychelles to Professor Selenka, and lately he had had a list of the species returned to him; among these were two new species, *Phyllophorus raphioderma*, and the species of which some of the calcareous plates were now exhibited. A full list of the species, with descriptions of the new ones, will, it is expected, be published in a short time.

Mr. Thiselton Dyer exhibited longitudinal sections from the stem of the plant of *Pandanus utilis*, which had recently been destroyed by a fungoid disease at Glasnevin. He was anxious to call attention to a point in the structure of the fibro-vascular bundles which, as far as he knew at present, was altogether novel, at least it was not noticed in any of the more common authorities, though it could not have been completely overlooked. Round the periphery of the prosenchyma of the bundles, and arranged parallel to them, were strings or single rows of parenchymatous

cells; their bounding walls were rather thick, squarish in outline, and rounded at the corners. Each cell contained an oblong prismatic crystal with usually distinct pyramidal extremities, nearly filling it, and with its longest axis in the direction of the string; some of the crystals which were obliquely placed may have been dislodged in making the section. The careful examination of the crystals while *in situ* left no doubt as to their true nature; it was possible, moreover, with a little trouble to isolate them from their containing cells. They polarised distinctly, which showed that they at any rate did not belong to the cubic system. The general parenchyma of the stem contained an abundance of ordinary raphides, which Gulliver had also observed in the leaves and "bark." "Crystal prisms" were distinguished by Gulliver from raphides; these last were absent in *Allium*, while in the section of the genus to which the common onion belongs, prisms were abundant, and consist, according to Dr. Davy, quoted by Gulliver, of oxalate of lime and magnesia ('Ann. and Mag. Nat. Hist.,' 3rd ser. 13, pp. 293 and 509). In *Iridaceæ*, prisms consisting of oxalate of lime are very abundant (ibid., vol. 15, p. 212), while in *Bonapartea juncea*, as in *Pandanus*, raphides and prisms are both present (ibid., vol. 16, p. 408). For notices of crystalline bodies from the bark of several exogenous trees taken from the 'American Journal of Microscopy, see 'The English Mechanic' for June 2nd, 1871, p. 254.

Mr. Thiselton Dyer also called attention to the elliptical septate spores of a coniomycetal fungus, *Podisoma juniperi*, Fr. These showed the commencing appearance near the septum of the germinating filaments, which finally produce spores of the second order, homologous, therefore, with the sterigmata and primary spores borne by the sporophore of the Hymenomycetal Tremella.

Dr. Moore showed instructive (scorched) sections from pampas grass.

Mr. Archer drew attention to some examples of *Staurastrum oxyacanthum* (ejus), presenting the same peculiarity as that first pointed out by Dr. Barker in *Staurastrum gracile*, which, however, he (Dr. Barker) was inclined rather to regard as of specific value; that is, instead of presenting three arms in end view, being compressed or plane, and showing, consequently, only two arms in end view. Amongst the examples now exhibited some presented themselves with two arms only at each end or segment; some with two on one segment and three on the other; some with two on one segment and four on the other; and some with three on one segment and four on the other—all side by side. This departure from the typical form, especially the *plane* or compressed, was, however, much more scanty than Dr. Barker's plane or compressed form of *St. gracile* in the bogs in Co. Westmeath (near Mullingar), where the latter is the prevalent form, and, indeed, not rare, whilst the ordinary form in other places is so; but in *St. oxyacanthum*, not at all a rare species, the present is the first instance in which this departure from the ordinary form, that is, being compressed,

and possessing but two arms on each segment, has been noticed. As mentioned on a previous occasion, Mr. Archer was acquainted with a three-rayed form, doubtless but a form of *St. tetracerum*, and he was aware of compressed forms of the type of *St. dejectum* (not precisely appertaining to that species). These cases (of which the compressed form of *St. gracile* is much the prettiest as a microscopic object) would seem to go far to prove that certain species with two lateral angles only to each segment, usually referred to the genus "Arthrodesmus" (as *A. incus*, *A. convergens*), are truly but two-sided Staurastra (very good species indeed in themselves), and that Arthrodesmus, as a genus, ought to stand only for such forms as *Arthrodesmus octocornis*. It is now highly probable that other *tri-* and *quadri*-radiate forms may be found occasionally *bi*-radiate only.

Mr. Vereker showed hairs from seed of an, as yet, unknown plant, sent to him from Nepaul, these hairs somewhat resembling those of ivy leaves, and forming, polarised, a very pretty object. Some of these seeds had been sown, and he hoped in due time to be able to throw a further light on the nature of the source whence the present exhibition emanated.

Mr. Archer drew attention to examples of the encysted state of the individual "monads" of *Phalansterium consociatum* (Cienkowski) = *Monas consociata* (Fresenius, "Beiträge zur Kenntniss mikrosk. Organismen," t. x, f. 31; Cienkowski in 'Schultze's Archiv,' Bd. vi, p. 428, t. xxiii, xxiv, f. 29—33), quite as described by Cienkowski (*loc. cit.*). The cysts are thick, doubly-convex bodies, the circular edge rather acute; the opposite sides, however, are not quite equally convex, the acuteness of the edge being seemingly increased by one "valve" (so to call it) of the cyst seeming to project slightly beyond the edge of the other "valve." But it would be unnecessary to dilate upon what has been already so accurately described by Cienkowski; still the production of that phase of the recent *entity* itself, side by side with that observer's so lately published, though, indeed, rather rigid figure, would be, perhaps, accounted of some interest.

Mr. Archer thought he might be justified in showing once more examples, with zygospores, of *Spirotænia truncata*, these being taken from a distinct and distant locality, Co. Westmeath, those shown on the last occasion being from Co. Kerry, and the present being then the third time only this form had been met with in the conjugated state. The form must be called a rare one, though thus taken from wide apart sources, and found also in Cos. Wicklow and Dublin.

22nd June, 1871.

Mr. Crowe presented some vacated cases of the eggs of some insect found attached to the flowers of furze, remarkable for the singular and numerous spine-like decorations with which they were furnished, giving them an exceedingly pretty appearance

under a low power. It is a pity these specimens could not have been examined by some observer conversant with objects of this nature, with a view to investigation and identification.

Rev. E. O'Meara showed a new Pleurosigma from the "Sulu material," description and figure of which he will ere long publish.—He also adverted to an examination (though with a negative result) recently made by him of some earth taken contiguous to an example of the *Megaceros hibernicus*, obtained from near Maynooth, which is usually found to give a variety of diatoms; but, in the present instance, he found the earth devoid of all organization whatever.

Dr. Richardson showed various instructive preparations of vegetable subjects.

Dr. E. Perceval Wright exhibited preparations of the anchors and plates of *Synapta Beselii*, Jäg., which he had taken off Isle Praslin, in the Seychelles, thus adding to the already wide geographical range of this species. One specimen taken was between three and four feet in length, and in locomotion would now and then elongate itself to a still greater length. A coloured figure of this species is given by Schimper.

Mr. Keit showed some young plants or fronds of *Hydrodictyon utriculatum* cultivated from original examples obtained from England. He had obtained forms of two kinds; first one of irregular network and large-sized cells, and then from these appeared to be subsequently produced ordinary "nets." The fact, so far, did not seem to accord with generally accepted statements; he hoped, however, to prosecute his experiments, collating his results, and probably have an opportunity to bring the matter before the Club on a subsequent occasion.

Mr. Archer showed several pretty and interesting forms of "Flagellata," contenting himself just now with the mere exhibition, as their due examination would involve a considerable time, and perhaps many opportunities; possibly he would, on some future occasion, have the pleasure to draw the Club's attention to the elegant *wee* things, now under the microscope, more in detail.

Mr. Archer also submitted some fugitive preparations under reagents of one or two of his recent Rhizopoda, which seemed to throw some slight additional light on "structure" in these particular forms in question; but, as the experiments required a great deal of time and patience, as well as repetition, and the subjects for examination were often exceedingly precarious to obtain, and, even in comparatively rich material, mostly very difficult to encounter and bring under *manipulation*, he would defer for the present publishing any further remarks on the points brought forward which would seem to arise from the specimens exhibited.

20th July, 1871.

Mr. Crowe presented a number of active living examples of microscopic life under his instrument, moving in healthy vivacity, rotatoria, infusoria, volvocines, &c., &c., forming a highly interesting and attractive field of observation for the section of the meeting to whom the "marvels of pond life" were but little known.

Dr. J. Barker mentioned he had been experimenting still farther with his new paraboloid for higher powers, and stated he had found good results from having its upper surface ground convex; he hoped to have an opportunity of showing this modification ere long on his large stand (which of course he was unable to fetch with him), the fittings being unadapted for others.

Rev. E. O'Meara showed *Campylodiscus diplostictus* from the Sulu material; as he was preparing an account of the diatoms from this source, amongst others, for separate publication, he would refrain from expatiating thereon here.

Mr. Archer drew attention to a minute exceedingly elegant form of Phacus, so far as he could find out, certainly not identical with any described, which was taken amongst several other pretty things from certain ponds some miles from Tralee, on the Dingle road. This was in figure most like *Phacus longicauda*, though never twisted, but quite different therefrom in its not being prolonged posteriorly nearly so decidedly into a spine-like "tail," and especially in the superficies on both sides being beautifully marked by convergent longitudinal rows of darkish dot-like granulations; "eye-speck" posed considerably to one side, and the point whence emanated the flagellum was not indicated by the superposition, or, as it were, overlapping, of two rounded lobe-like portions of the "leaf-like" body, but only by a mere concavity. The dimensions of this very elegant little object were, length $\frac{1}{750}$, and greatest breadth $\frac{1}{1250}$, thus very nearly, if not quite, the most minute form referable to Phacus. However, Mr. Archer thought it would be desirable to be in a position to point to a figure of this little form, ere venturing to give any more full description, and would hope to refind it on some future occasion.

Mr. Archer would have directed the Club's attention, had time permitted, to yet another example, in addition to others lately pointed out by him, of motion without (visible) motory organs, in certain humble forms of organisation in which this had (he thought) not been noticed, though well known, of course, in many other cases, such as Bacteria, Diatoms, &c. &c. The present case was that of a minute *algal* organism, *like* the little reddish form adverted to by him and shown at the Club Meeting of 26th Jan., 1871 ('Quart. Journ. Micros. Sci.,' vol. xi, N. S., p. 311), but not at all identical therewith. This was found in the same gathering yielding the new Phacus above alluded to. So insignificant a little affair, indeed, is the present, that but for its movement,—a rolling, wavering,

tumbling, jerking kind of revolution hither and thither, not however at all always displayed,—it would hardly attract notice; and, when attention might become arrested, so little apparent "structure" was evident, it would be no very great stretch of imagination to suppose that a number together of these variously sized though always minute little bodies were so many quartzose granules moving about—a kind of "animated sand"—gleaming however with more or less of alternating reddish or bluish sheen. That they were really composed of groups of minute chroococcaceous cells combined into a "shapeless" aggregation by a common matrix, the application of potash showed; but, as in some other minute organisms, by what *agency* the little cluster *moved*, remains equally a problem. It may be well here to dissipate at once any assumption that this motion was merely "molecular;" it was clearly not so, but a decidedly vigorous and energetic, though more or less vacillating and fitful, locomotion, from place to place, hither and thither, "at random." But as it would appear almost impossible to convey in Minutes like these, unassisted by anything in the way of a figure, an idea of *what* such a thing as the present was really like, it would be but a waste of space to try to enter into any more lengthened description of this little affair here. To some extent, of course (in the fact of motion, in the chroococcaceous nature), it comes close to Bacterium, and allies—but it differs too, both in the *kind* of motion or mode in which it is executed, and in structure, if such term might be considered allowable in a thing such as *this*. It is possibly not uncommon, but may be overlooked readily in the quiescent condition; inasmuch as it may turn up for exhibition perhaps some time again, and owing to the difficulty of expatiating on it here to any good purpose, it is just as well to leave it in abeyance.

Resolved,—That this Meeting of the Club cannot separate without placing on record the regret with which they have just heard the intelligence of the death of Robert Callwell, one of the earliest Associate Members of this Club, and one of the founders of the old Dublin Microscopical Society, now many years dissolved. He was always ready to give any assistance in his power to the microscopist, and his loss will be felt as a personal one by many of the Club Members.

17*th August*, 1871.

Rev. Eugene O'Meara exhibited an example of a new Navicula—*N. spiralis*—possessing what appeared to him to have the aspect of a siliceous coil running on each side of, and close to, the median line, and as if external to, but yet attached upon, the frustule. It became a question of debate as to whether this was an actual independent spiral composed of silex or a kind of marking simulating such. If indeed the former, it had, at least in certain states of the focus, much the appearance of the latter. Mr. O'Meara leant rather to the former opinion.—Mr. O'Meara likewise exhibited *Campylodiscus Normannianus*.

Mr. Crowe drew attention to one or two instances of a curious, as it were, arrested state of the conjugative process in *Staurastrum cuspidatum*. This consisted in the united mass, formed from the contents of the two parent cells, not becoming wholly withdrawn from their cavities, but, in such partly-advanced stage, becoming clothed with a cell-wall, this abnormally-formed (or precocious) zygospore retaining more or less of a sub-cruciform or quadrate figure, the four halves of the two parent cells being retained at the angles—this, induced partly by the common mucous envelope and partly by a kind of expansion or dilatation of the angles of the misshapen zygospore, projected into the cavities of the empty parent segments and larger than the foramen. Thus the whole gave in one aspect a pretty well-shaped figure of a Maltese cross—in another presenting an elliptic outline surmounted at each end by the empty segment of one of the parent cells, and then each of these latter not unlike a "cocked hat" poised on each visible apex. The whole had thus a curious and bizarre appearance, and to some extent deceptive, especially until examined under a comparatively high power; but its singular shape seemed then quite obviously to be produced by the united contents of the conjugating cells becoming clothed with a wall before the common mass had as yet become balled together into the typical orbicular figure.

Mr. Archer exhibited examples of a plane or compressed variety of *Staurastrum vestitum*, that is, each segment possessing *two* arms only—a companion thus to Dr. Barker's plane variety of *Staurastrum gracile*, and thus bearing out Mr. Archer's view that such as these are but accidental, though in no way abnormal, representatives of certain species, not (at least on that account) distinct species in themselves—for, in point of fact, examples two-armed on one segment, whilst three-armed on the other, were to be met with in the present material; but still in the Westmeath pools the plane form of *Staurastrum gracile* is the pervading one.

Mr. Archer showed an example, dyed by carmine solution, of the large "*Amœba-actinosphærium-like*" Rhizopod, of which clearly remarkable form he had exhibited living examples at the Club Meeting of 29th Sept., 1870 ('Quart. Journ. Micros. Sci.,' vol. xi, N. S., p. 101, which please see), and which he thought would prove to be identical with the rhizopod forming the type of Grenacher's new genus Pelobius. As he (Mr. Archer) had given a brief record already (*loc. cit.*) of the particular rhizopod he at least had in view, which might, he hoped, serve to identify it if met with in this country by others, it would be unnecessary to recapitulate in any way on the present occasion, especially as it is to be expected that Dr. Grenacher's promised description, with plate, of his Pelobius may ere long make its appearance; for indeed, until then, the identity of that with the present could not be considered as at all certain. But meantime Mr. Archer ventured to hope the present fugitive preparation, showing the numerous nuclei (or capsules ?), highly dyed by the solution, would be viewed by the meeting with a certain amount of interest.

Mr. Archer desired to record the occurrence of two interesting, if not very striking organisms, for the first time noticed in this country, or indeed (he thought) anywhere, save by the original discoverers. One of these was *Phalansterium intestinum* (Cienkowsky); the other *Drepanomonas dentata* (Fresenius). It was only a short time since that, in these Minutes ('Quart. Journ. Micros. Sci.,' vol. xi, N. S., p. 208) Mr. Archer, in referring to the other form (or forms ?) appertaining to the type constituted into a new genus by Cienkowsky, *Phalansterium* (Schultze's 'Archiv für mikros. Anatomie,' Bd. vi, p. 428), had stated that the present one, *Phalansterium intestinum*, had not occurred in this country. That was then, indeed, true. However, very lately, on taking a run up to the "Rocky Valley" near Bray, in company with Mr. Crowe, they brought back examples of this organism. On examining the gatherings at home, Mr. Crowe's attention was arrested thereby, and indeed it was not until turning over some material, with a low power, for the purpose if possible of finding some further cases of the curious abnormal state of the conjugation in *Staurastrum cuspidatum* (found in the same place, as it happened), that Mr. Archer became aware that their gatherings contained so interesting a "take." Unattractive, indeed, as *Phalansterium intestinum*, as a mere object, might be regarded, it is still too marked a thing to hesitate a moment as to its identity—indeed, Mr. Archer detected it at once under a "one inch," and an examination under a "quarter-inch" left no room for doubt. Very likely after all this may not be a rarity in suitable situations, but it is not less a fact, it has not hitherto attracted notice. It would be quite unnecessary here to go into detail in connection with this form, as no additional information to what Cienkowski has already afforded (*loc. cit.*) could be made out. Just as in that observer's original specimens, not any here showed the *encysted* state of the constituent "monads," which appears to be not very uncommon however in its ally *Ph. consociatum*; examples of the latter in the encysted state were shown by Mr. Archer to the Club at the meeting of May 18th, 1871 (*antè*). As Cienkowsky remarks, it is just possible that *Ph. intestinum*, if only casually observed, *might* be overlooked for some string of excrementitious matter; but the pretty sharp cylindrical outline, formed by its long, curved strings, and, under a higher power, the pale spots readily seen in the granular reddish matrix, produced by the *monads* themselves, and the faint play of the flagella around, at once dissipate such an erroneous assumption. It is possible that the reddish and somewhat large form, referable to this genus, adverted to by Mr. Archer on a previous occasion (*loc. cit.*), *may* be a younger or modified form of *Ph. intestinum*, and *that* at least is here and there occasionally met with; but any decision as to this point may be a question for the future.—The other organism now recorded as new to Britain—*Drepanomonas dentata* (Fresenius)—came from Co. Westmeath gatherings. This does not seem to be recorded since Dr. Fresenius found it at Wallsdorf, years ago; but it is far too marked, indeed too quaint an organism, to doubt as to its identity.

Mr. Archer had detected this in the same locality once or twice before, but—though seeing its curious broadly falcate figure, irregularly dentate at each end, somewhat swollen and minutely cuspidate at the concave margin, was unique—its identification had been until now overlooked. He regretted he had not examples of either of these organisms to show "in the flesh" to the Club; it is a pity that objects, such as these, cannot be commanded to appear "to order;" but, on the contrary, just when wanted, very often that is the time they *won't* put in an appearance. Well, for the present it couldn't be helped, and he could only hope that a future search might bring both to light in good order for exhibition on some subsequent occasion.

Royal Microscopical Society.

January 11*th*, 1871.

Read a paper "On the Anatomy of *Ascaris lumbricoides*," by Mr. B. T. Lowne.

February 8*th*, 1871.

The Annual General Meeting of the Society was held. James Glaisher, Esq., F.R.S., V.P., in the chair, on account of the death of the late President. A statement was made by the Secretaries of the Society's operations during the past year, and Mr. Slack "added a *résumé* of some recent investigations with minute organisms." From the treasurer's balance-sheet it appears there is due from him to the Society £34 2*s*. 7*d*. The increase of the members of the Society during the past year was one.

Mr. W. R. Parker, F.R.S., was elected President for the year.

March 1*st*, 1871.

At this meeting it was agreed that, on the ground of expense, the usual *soirée* and evening party should not be held this year.

Two papers were taken as read—one "On views of *Surirella gemma*," by Dr. Gagliardi, and another "On the Winter Habits of Rotatoria," by Mr. Cubitt.

Two papers—one, "On the Microscopic Examination of Water for Domestic Use," by Mr. J. Bell; and another, "On the Structure of the Podura Scale and certain other Test-objects, and of their representation by Photo-Micrography," by Lieut.-Colonel Dr. Woodward—were read.

The President made some remarks on the development of the skull in vertebrate animals.

April 5*th*, 1871.

The President, who was in the chair, read a paper "On the Mode of Working out the Morphology of the Skull."

Mr. Slack handed in a paper "On the Optical Appearances of Cut Lines on Glass."

A paper was read "On Linear Projection considered in its Application to the Delineation of Objects under the Microscope."

May 3rd, 1871.

A paper was read "On the Structure of Lepidopterous Scales as bearing on the Structure of *Lepidocyrtus curvicollis*," by Dr. Maddox.

A paper was read "On the so-called Suckers of *Dyticus*, and the Pulvilli of Insects," by Mr. Lowne.

June 7th, 1871.

A paper was read "On Mycetoma, or the Fungus-foot Disease of India;" also a paper by Dr. Braithwaite "On the Structure of Bog Mosses."

October 4th, 1871.

The first meeting of the session was held on October 4th, 1871, Mr. W. Kitchen Parker, F.R.S., President, in the chair.

Mr. Parker contributed a valuable paper "On the Development of the Facial Arches of the Embryo Salmon," at the conclusion of which he expressed his opinion that the development of the brain case of the osseous fishes demonstrates that group to be much more closely allied to the Sauropsida, or birds and reptiles, than it is to that of the Batrachia, or frog tribe. Mr. Parker highly eulogised the use of chromic acid as a medium for hardening, without distorting, the substance of the brain when required for sections.

Dr. Spencer Cobbold handed in a report on some preparations of entozoa, with accompanying notes, forwarded to the Society by Mr. Morris, of Sydney, and made observations on some of the most interesting forms of the fine species collected by Mr. Morris. Dr. Cobbold stated that by far the greatest amount of importance was to be attached to the discovery in Australia of *Stephanurus dentatus*. This entozoon was introduced to the scientific world as early as the year 1834 by Natterer, who found it in large quantities infesting the adipose tissues of a breed of Chinese pigs on the Rio Negro, in Brazil. Up to the year 1870 nothing further was heard of this parasite, when Dr. Cobbold received a communication from Prof. Fletcher, of New York, stating that it was committing great destruction among the pork-raising districts of the United States, thousands of pigs in some localities falling victims to its ravages. In aspect and structure Stephanurus bears a close resemblance to Trichina, but is of much larger size, the cysts of the former frequently measuring an inch or an inch and a half in length; its greater magnitude is the principal safeguard against its introduction into the human subject.—(*Nature*, October 12th, 1871.)

November 1st, 1871.

W. Kitchen Parker, F.R.S., President, in the chair. Dr. Braithwaite, F.L.S., contributed further remarks on the structure of the Sphagnaceæ or bog-mosses. Confining himself principally to the characters for grouping the numerous species into sub-genera, he advocated the system adopted by Dr. Lindberg of Stockholm, based upon those yielded by the form of the leaves investing certain portions of the stem and divergent branches.

Mr. W. Saville Kent, British Museum, read a paper on Prof. James Clark's Flagellate Infusoria, with description of new species. In his communication Mr. Kent announced the discovery among others of Prof. Clark's minute "collared" types (*Codosiga*, *Bicosœca*, &c.), first made known to the scientific world through the 'Memoirs of the Boston Society of Natural History' for 1866, but not since corroborated by any European naturalist. Of the eleven specimens noticed by Mr. Kent, five were identified by him with American forms; the remaining six, while referable to corresponding genera, offering well-marked specific distinctions. The whole series are of exceedingly minute size, requiring a magnifying power of 800 diameters and upwards for the recognition of their structural peculiarities, the chief interest attached to them being their striking resemblance to the ultimate cell-particles lining the incurrent cavities of sponges, as clearly shown by Prof. Clark in the calcareous, and since demonstrated by Mr. Carter in the siliceous, groups. Mr. Kent expressed his dissent from Prof. Clark's views in regard to the nutritive functions of *Monas* and other Flagellata, in the course of his investigations, he having observed the former to engulf food at any portion of its periphery, after the manner of *Amœba*, while in the collar-bearing species it was intercepted at any portion within the area circumscribed by the base of that organ, there being in no case a distinct mouth as assumed by Prof. Clark. In the discussion that ensued Mr. Kent assented to the President's suggestion, that the Flagellata, in the possession of one or more lash-like appendages, represented a higher type of organization than the Foraminifera, and other Rhizopodous Protozoa; and expressed his opinion that the Spongiadæ, as a class, combined the structural characters of the ordinary Rhizopoda and lower Infusoria, having superadded to this a skeletal and aggregated type of organization essentially their own. Mr. C. Stewart stating that he had observed an appearance of three flagellate appendages to certain cells of *Leucosolenia botryoides* under a magnifying power of about 300 diameters, Mr. Kent accepted his statement as further corroboration of the existence of a membranous collar, which, under an insufficient degree of magnification, presents the aspect attested to by Mr. Stewart. The entire series of infusorial forms recorded in Mr. Kent's communication were obtained by him from a pond on the estate of Mr. Thos. Randle Bennett, Wentworth House, Stoke Newington. —(*Nature*, November 9th.)

December 6th, 1871.

W. Kitchen Parker, Esq., President, in the chair.—A communication from the Chevalier Huyttens de Cerbecq was read, having reference to the minute structure of the scales of insects, and specially to Mr. M'Intire's observations thereon. Papers were also read on the following subjects:—"On the Markings of Battledore Scales of Lepidoptera," by Dr. Anthony, of Birmingham; and "On the Nerves of the Capillary Vessels, and their Probable Action in Health and Disease," by Dr. L. S. Beale. A discussion followed the reading of Dr. Beale's paper, in which Drs. Berkart, Murie, Leared, Lawson, and Messrs. Stewart and Hogg, took part. The following gentlemen were elected Fellows of the Society:—Messrs. C. H. Roper, J. Rogers, J. F. Payne, and C. Croydon.

Quekett Microscopical Club.

November 24th.—Professor Lionel S. Beale in the chair. A paper was read by Mr. M. C. Cooke on "The Minute Structure of Tremelloid Uredines (*Podisoma*)," in which the structure of the Tremelloid masses, commonly found on juniper bushes, was detailed, together with the results of the observations of Tulasne, Oersted, and others on the germination and development of these fungi, with a critical examination of the species described under the genera *Gymnosporangium* aud *Podisoma*. It was held by the author that no good foundation existed for the constitution of two genera, since the minute structure and development of both were identical. Some conversation ensued on the phenomena of alternation of generations which these and other fungi present, and especially in cases where some of the phases of existence were presumed to be passed on different hosts. Especial reference was made to the opinions entertained by Professor Oersted that the Podisomas were found in one state parasitic on leaves of Pomaceous trees, as Rœstelias, &c., in another stage inhabiting the branches of junipers, as Podisoma. The author of the paper did not consider that this supposed phenomenon was satisfactorily proved.—*Nature.*

Literary and Philosophical Society of Manchester.

Microscopical and Natural History Section.

Ordinary Meeting, April 24th, 1871.

Joseph Baxendell, F.R.A.S., President of the Section, in the chair.

A paper was read "On the Microscopical Examination of Dust blown into a Railway Carriage near Birmingham," by Joseph Sidebotham, F.R.A.S. A rough examination with a two-third's power of this dust (collected on a paper placed near the window) showed a large proportion of fragments of iron, and on applying a soft iron needle it was found that many of them were highly magnetic. They were mostly long, thin, and straight, the largest being about the one hundred and fiftieth of an inch, and under the power used had the appearance of a quantity of old nails. The weight altogether of the dust collected was 5·7 grains, and the proportion of these particles composed wholly or in part of iron was 2·9 grains, or more than one half. The iron thus separated consisted chiefly of fused particles of dross or burned iron, like "clinkers;" many were more or less spherical, like those brought to our notice by Mr. Dancer from the flue of a furnace, but none so smooth; they were all more or less covered with spikes and excrescences, some having long tails like the old Prince Rupert's drops. There were also many small angular particles like cast iron, having crystalline structure. The other portion of the dust consisted largely of cinders, some very bright angular fragments of glass or quartz, a few bits of yellow metal, opaque white and spherical bodies, like those described by Mr. Dancer, grains of sand, a few bits of coal, &c.

Mr. Charles Bailey drew attention to the similar observations of Mr. Charles Stodder, of Boston, U.S.A.

Mr. Walter Morris read a paper upon "The Adulteration of Food," principally with reference to its detection by the microscope.

Specimens of many kinds of adulteration, mounted for the microscope, were exhibited at the meeting.

Annual Meeting, May 8th, 1871.

Joseph Baxendell, F.R.A.S., in the chair.

A paper was read by Dr. Simpson, entitled "Observations on the *Bilharzia hæmatobia* (Cobbold)." This entozoon is very prevalent in some hot countries, especially in Egypt and the Cape of Good Hope, where it is the cause of the hæmaturia endemic in those countries; a case illustrating its history had come under observation at the Manchester Infirmary.

The report of the Council and Treasurer's account for the past year were then read and passed, and the election of officers for the year 1871-72 took place.

November 6th.

A paper was read on '*Trichophyton tonsurans*,' by Mr. John Barrow.

East Kent Natural History Society.

President, the Rev. John Mitchinson, D.C.L., &c., Oxon.; Honorary Secretary, George Gulliver, Esq., F.R.S.

As its name imports, this Society is by no means confined to microscopical work. But the name of the Honorary Secretary will afford sufficient guarantee that both animal and vegetable histology are well prosecuted; and of these departments we propose to give reports. Indeed, the Society presents a remarkable sphere of usefulness in the application of the microscope to natural science, as at the scientific meetings, which are held fortnightly at Canterbury, it is the usual course to make the dissections of animals and plants, and the microscopic demonstrations thereof, in the presence of the members.

December 7th, 1870.—Living specimens of *Trichodina* and *Vorticellina* were exhibited by Mr. Fullagar; when the longitudinal central muscle of *Vorticella* was well shown by Mr. Sidney Harvey. Mr. Gulliver gave practical demonstrations of the microscopic structure of the so-called scales of *Anguis fragilis*, proving that the dermal scales of this reptile are true bone and not horny epidermis; an important fact, as another evidence of the lacertian affinities of this creature, since in true Ophidians the scales are horny epidermis, and not bone.

January 11th, 1871.—The branchiæ and the circulation of the blood were examined in some Entomostraca, and an explanation of the difference between gills and lungs was given, both in vertebrates and invertebrates, and of the special function in relation to respiration of the red blood-corpuscles of vertebrates.

January 25th.—Colonel Horsley gave some demonstrations of plant-crystals—Raphides, Sphæraphides, and Crystal Prisms; whereupon Mr. Gulliver showed the very great importance of such crystals, especially rhaphides, in taxonomy. Thus, for example, in the British Flora, the shortest and sharpest diagnosis of the order Onagraceæ would be Calycifloral Exogens abounding in raphides; of Galiaceæ, Corollifloral Exogens abounding in raphides; of Orchidaceæ, Gynandrous Endogens abounding in raphides; of Hydrocharidaceæ, Hydral Endogens destitute of raphides. And similar exemplifications might be multiplied extensively, as may be seen in Mr. Gulliver's various memoirs in the 'Popular Science Review,' Oct., 1865; 'Ann. Nat. Hist.,' 1861-65; 'Quart. Journ. Mic. Sci.,' 1864, 1865, 1866, and 1869; and 'Seeman's Journ. Bot.,' 1864, 1866, 1867, and 1869. The raphidian character was represented as so eminently natural, so easy to realise, and often so much more universal and fundamental than other single diagnostics, as to make it surprising that systematists, still exclusively using the old diffuse and often difficult characters, should not yet have taken advantage of it.

February 8th.—Mr. Harvey displayed some Rotifers; and Mr. Fullagar some young of *Paludina vivipara*, bred in his aquarium. Miss Croasdill sent some specimens of Velella collected at Tenby, and a discourse was given on the structure and economy of the class of Acalephes.

February 22nd.—Mr. Fullagar exhibited the Crystal Prisms of Quillaia bark, showing their large size, and how, in their shafts and tips being prismatic or angular, they differ from Raphides. These last have rounded shafts, and occur loosely together in bundles, and may thus be easily known from crystal prisms; which prisms proved to be excellent for experiments with polarised light, while true raphides are not so. It was observed that the order Iridaceæ abounds in crystal prisms; and that the well-known *Iris Germanica*, so common in our cottage gardens, is a good plant, always at hand, in which to examine them.

March 8th.—Col. Horsley and Mr. Bell displayed some Diatoms; and Mr. Down some of the Canterbury mosses, with dissections of the sporangium and peristome of *Hypnum confertum*. Mr. Fullagar showed several specimens of freshwater Polyps, some of which were bred in his aquarium, as he believed, from eggs deposited there by the parents during the preceding autumn.

March 22nd.—Col. Horsley gave demonstrations, from preparations made extemporaneously, of the characters of the Crystal Prisms of Guaiacum, and of the Sphæraphides of the prickly pear (*Opuntia*); whereupon the Hon. Sec. observed that these prisms are good tests of the genuineness of the officinal barks of Quillaia and Guaiacum, and that though the crystal prisms are abundant in many British Endogens, and in various exotic Exogens, including trees and shrubs, these crystals had not yet been found in our native Dicotyledons. And, indeed, while in foreign exogenous trees and shrubs true Raphides are not uncommon, they have not at present been demonstrated in any British trees.

April 13th.—Mr. Bell, Mr. Fullagar, and Mr. Down, displayed some lively specimens of *Volvox* and *Closterium*, and some very fine ones of *Sphærosira*. The circulation of the sap, and the multiplication by binary subdivision, were well shown in *Closterium lunula*.

April 27th.—The Rev. C. W. Bewsher exhibited a fine specimen, bigger than a bucket, of 'Neptune's Cup,' like that originally described by Hardwick, in the 'Trans. Lin. Soc.,' as a Sponge allied to Cliona. The present example came from the Mauritius. The character of its siliceous spicules was shown under various microscopic powers. *Hydra viridis* and *H. fusca*, now very abundant about Canterbury, were shown by Mr. Fullagar and Mr. Bell, when the process of multiplication by budding was well seen.

May 11th.—Mr. Gulliver exhibited specimens of Planer's Lamprey, now very abundant in the Stour River, at Canterbury, and gave demonstrations of several points of the anatomy, not yet recognised in the systematic books, concerning the Petromy-

zonini :—1st. *The red Corpuscles of the Blood*, though circular, agree in structure with the same corpuscles of all other Pyrenæmata. 2nd. Though usually described as "Dermopteri without *Fin-rays*," these rays, composed of cartilage-cells, were plainly shown in the fins of these fishes. 3rd. The *Lens-fibres* are smooth, being destitute of the indentations and interlocking of the edges, so characteristic of most fishes. 4th. The male has at this season a distinct *Penis*, and the females a similar but broader and shorter process. The organ in both sexes has a single central and longitudinal canal, through which the generative and urinary products pass; and it is probable that there is a true copulation. 5th. *Platyelminthes* in the brain in every one of the Lampreys that were examined, and these Entozoa so abundant as to fill the space between the skull and brain, and often pressing into the cerebral substance, but not found in or about the nerves elsewhere. These new worms may be called, provisionally, *Neuronaia Lampetræ*, as being allied to, though very different from, *N. Monroii*, described by Goodsir, in the nerves of the cod-fish family. Many of these facts are detailed and figured in the 'Proc. Zool. Soc.,' December 6th, 1870.

May 25th.—No microscopic business, the meeting being occupied with Mr. Fullagar's description of the metamorphoses of Libellula, and by Mr. James Reid's observations on the labellum in *Orchis fusca* and the allied species.

June 8th.—Mr. Fullagar and Mr. Harvey showed the vibratile cilia on the surface of the gills of a larval Triton. Mr. Gulliver exhibited what he described as the Intestinal Respiration in a worm of the Naid family. This creature, common in the pools about Canterbury, is colorless, about a quarter of an inch in length, very thin, with flat segments, mostly having long and slender lateral hairs, and the body so pellucid as to admit of admirable views of the phenomenon. The vivid action of the vibratile cilia within the intestine, and the rapid and incessant current of the water over the cilia, afforded a most remarkable spectacle, and left little doubt that this is a true respiration, heretofore so obscure, in the abranchiate worms. Mr. Gulliver added that the action may be seen in *Sænuris variegata*.

June 22nd.—The manner of feeding, and the structure of the nettle-cells and threads of the *Hydra* polyps were exhibited by Mr. Fullagar and Mr. Harvey; and Mr. Bell displayed the structure of the Spiracles and Tracheæ of insects. Extemporaneous preparations were made and examined, of the peculiar leaf-cells of Sphagnum; and in like manner the Osseous Granules were shown in an insectivorous mammal, and in the boiled bones of the codfish.

July 5th.—The members of the Society were hospitably entertained by Colonel Horsley, at his residence, St. Stephen's Lodge. The anatomy of a fresh female specimen of *Gordius* was explained. Mr. Fullagar presented beautiful examples of the Stigmata, and their perforated plates, of *Ixodes ricinus.* Mr.

Gulliver gave a lecture "On British Reptiles and Batrachians, with a comparison of the red corpuscles of their blood with those of certain exotic species." Though the characters afforded by the blood-disks have not yet found their place in systematic zoology, they are so important that they must soon be regularly recognised. He showed specimens of these corpuscles from all our indigenous Reptiles and Batrachians, and from the foreign *Siren*, *Proteus*, *Amphiuma*, *Menopoma*, *Menobranchus*, *Cryptobranchus*, *Siredon*, and *Lepidosiren*. The blood-disks of the Proteus were long regarded as the largest known, but a late discovery had shown that they are still larger in Amphiuma. And, so far as regards the blood-disks of Lepidosiren, they must be placed, as the lecturer had long since discovered, among the several Batrachian characters of this singular creature; no true fish has such large red blood-corpuscles. The comparative examinations were all made in the presence of the meeting, and it was pleasing to see how easily Col. Horsley and his guests were led to realise the main points, and to perceive the relation of the size of the blood-disks with the respiratory function, especially when the comparative smallness of the blood-disks of mammals was shown.

July 20th.—Several examinations were made regarding the ordinal characters afforded by Raphides in English exogenous plants, and all found to be quite true, after protracted inquiry among numerous specimens of Onagraceæ, Balsaminaceæ, and Galiaceæ, and of numerous plants of allied but exraphidian orders. It was easy to distinguish by the raphidian diagnosis, even in the minutest portion, all species of these three orders from species of any other order of the same alliance as that to which the raphidian plant belonged.

August 3rd.—Mr. George Gulliver, of Pembroke College, Oxford, gave demonstrations of the Sphæraphides of the order Caryophyllaceæ, especially in fresh specimens of *Dianthus armeria*, which is not uncommon about Canterbury. The raphidian character of all the British species of *Lemna* was shown in contrast with the exraphidian *Wolffia*, all in fresh specimens from the neighbourhood of Canterbury.

August 17th.—The examination of plant-crystals was continued with the same results. A Paper "On the Comparative Anatomy of the British Scaly Reptiles," was read by Mr. G. Gulliver, late scholar at the King's School.

August 31st.—The beautiful Lepides of the epidermis of *Callitriche* were examined. They are not unlike in outline to the flat rose-ornament of mediæval architecture, and are very characteristic, though not yet recognised by systematists. The curious trumpet-shaped Micropyles in the egg of *Locusta viridissima* were displayed.

September 14th.—1. *How easily to see the Markings of Pleurosigma;* by Colonel Horsley.—It is well known that these markings are so difficult of resolution that much accessory apparatus and very nice management of the light are considered necessary

for the purpose. Thus costly accessories, such as achromatic condensors, Webster's condensor, Reade's prism and hemispherical condensor, and other contrivances for providing suitable illumination are used, much to the profit of opticians. But, Col. Horsley's experiments raise the question whether these expensive appliances may not be altogether discarded; and though this cannot yet be affirmed, he exhibited in a very simple manner the markings of the valves of Pleurosigma. This was done by taking the light in a plane with the object, and dispensing with the glass reflector and the condensor, so that the only reflected light was derived from the inside of the short plated tube under the stage of the microscope; and the luminous rays thus faintly and obliquely transmitted proved quite efficient in rendering the markings plainly visible under objectives of one fourth of an inch focus.

2. *On Points in the Intimate Structure of British Euphorbiaceæ;* by Mr. Gulliver.—Referring to his memoir on the Latex of plants, published in the 'Annals of Natural History' for March, 1862, the author announced that he had some new points to display to the meeting. Selecting first a fresh specimen of *Mercurialis annua*, he showed that this plant abounds in Sphæraphides, and to such an extent that it affords an excellent indigenous exemplar of them. And the interest of this fact is increased, because it presents a good diagnostic between the genus *Mercurialis* and all the other British Euphorbiaceæ; and this character, though so easily seen, is quite ignored in the systematic and other works on botany. Nor is it less noteworthy that the very curious starch-sticks of *Euphorbia* afford an equally distinct and sharp character of this genus among the British Euphorbiaceæ; these rods of starch not having yet been found in any British plant of other orders, if, indeed, in any other order native or exotic. The author observed that such characters in this point of view, including those afforded by raphides, hairs and cells of the epidermis of Phanerogams were of great importance, and that it seemed remarkable that only Dr. Lankester and Professor Balfour had yet at all recognised this valuable addition to taxonomic botany.

September 28th.—Sænuris variegata.—Specimens of this worm, each about an inch in length, and collected at Canterbury, were exhibited at the meeting. Whereupon the Honorary Secretary and Vice-President (Mr. Gulliver) gave descriptions as follows:—The present animal is a member of the Bristle-footed Worms (*Annelida setigera, s. Chætopoda*). These being devoid of gills or other special organs for breathing, and commonly androgynous, are known to zoologists as Abranchiate and monoecious Annelida. As shown at a former meeting, the respiratory function in this family is probably carried on by means of the vibratile cilia with which these creatures are so plentifully supplied within the intestinal canal and elsewhere. They have a distinct ventral nervous chain with ganglia; and a well-marked vascular system, of which the great vessel on the back is the

centre. The blood is red, like that of several other members of the same order, as the common earthworm, &c. *Sænuris tubifex* and *S. vagans* are abundant about Canterbury; but though *Sænuris variegata* is by no means a rare species, no previous record of its having been found here is known. It is the most beautiful worm of its tribe, being very curiously variegated in colour, which appears the more remarkable from the transparency of the creature admitting a view of the great blood vessel. This was accordingly displayed under the microscopes before the meeting, when the contractions of the vessel and the moving blood presented a curious spectacle, and an excellent example of the vascular system of the Bristle-footed Worms. Indeed, from the ease afforded by the transparency of this species for views of the blood-vessels, the viscera, and the vibratile cilia, this creature is highly prized by those zoologists who desire to be eye-witnesses of these phenomena; and no one can behold such curiously complex structures without a feeling of admiration that these animals, seemingly so abject in the zoological scale, have really a marvellous and high organization, including a respiratory apparatus.

Spongiadæ.—The Honorary Secretary while explaining living examples of *Spongilla fluviatilis*, took the opportunity of making some remarks on the very interesting class of Sponges, which has long been bandied about between the botanists and zoologists, (and has not escaped the moralists), but has at length, by common consent, been peremptorily settled in the animal kingdom. A sponge consists of a skeleton or frame-work invested by the soft living or organic parts. There are regular canals for the circulation or rather passage of the water, with mouths or pores to receive the incoming currents, and openings ('oscula') or vents for the outgoing currents, regularly carried on by means of vibratile cilia. All this might seem merely curious; but in truth it is highly important, as relating to central or fundamental phenomena in physiology. The main facts were discovered by Dr. Grant, the eminent Professor of Zoology at University College, now an honoured veteran, still happily spared to that science which he has adorned throughout Europe, and since admirably reflected to Asia and America. And it is remarkable that Harvey's discovery of the circulation of the blood of the higher animals had remained a great fact, for centuries before Grant demonstrated the analogous process in such abject creatures as the Sponges. Of these the soft living part is composed of a jelly-like and amœboid substance (sarcode), receiving air and food through the pores, and very prone after death to prove its animal nature by putrefaction; of which last fact any zoologist who may engage in experiments on the Sponges of our seas and fresh waters is likely to have unpleasant experience. Though the mature Sponge is as fixed as an oyster, at an earlier period of its existence, like the youngest oysters, that sponge had been a tiny and free-roving animal, careering about at its own will by means of its vibratile cilia; and having thus sported through its

infancy, became finally settled down to pass the remainder of its life in some fixed abode, there to fulfil its destiny by perpetuating its species. And this is effected, as is many other low animals—the polypes, for example—in two modes; by the production of buds (gemmæ) which assume the cilia and freedom already mentioned, or by the agency of ovaries. Hence we have an animal belonging to a class far beneath that which includes the oyster; in short, the Sponges form a class, allied or belonging to the Protozoa, and known as Porifera, so named from the inhalent and exhalent orifices before described. The skeleton of sponges is always composed of flexible fibres or laminæ, or of rigid spicules; and these are either of horny matter, of carbonate of lime, or of flint. So we have the orders Keratosa, Calcarea, and Silicea. The horn-like material is soft and elastic when damp, as we are familiar with it in the sponge of commerce; and being of a peculiar nature, is named Keratode, which is chiefly fibroin, a quaternary compound nearly allied to silk, and not found in the Vegetable Kingdom. Thus, besides the zoological characters before mentioned, we have a proof from chemical investigation of the animality of the Sponge. Fibroin of Sponge contains or is associated with a notable quantity of iodine, sulphur, and phosphorus. The Sponges most commonly known, as well as the living specimens of *Spongilla* shown to the meeting, have no particular shape; and indeed from this fact they were formerly included by De Blainville in a class which he called Amorphozoa. But further researches soon proved the insufficiency of this characteristic; as indeed had been exemplified not long since before the East Kent Natural History Society. One of those examples was a large and grotesque form like a big bucket or tub incrusted with a knobbed layer of stone, standing on a thick pedestal, with a gnarled branching base resembling the root of an old tree, and all crusted similarly by the hard mass composed chiefly of microscopic spicules; and thus presenting a shape so remarkable as to become popularly known by the name of Neptune's Cup. It is allied to the genus *Cliona*, came from the Mauritius, and was submitted to the society, on the 27th of April, by the Rev. C. W. Bewsher. Another, of surpassing beauty of detail and regularity of shape, with its spicules so exquisitely arranged as to present a delicacy of filigree or fretwork on the surface that no art could emulate, and the whole fashioned like the horn of Amalthea, is known as Venus's Flower Vase (*Euplectella*); and for an opportunity of examining this elegant form, the society had been indebted to Mr. Sibert Saunders. Venus's Flower Vase came at first from the Manilla seas. On the other hand, the little sponge brought before the meeting on Thursday last is common in Britain, quite shapeless, and not at all remarkable for external beauty; though its skeleton is very beautiful, being composed of colorless spicules of flint, as transparent as the finest rock crystal. Thus this species belongs to the Silicea, as do all the few Spongillæ of our fresh waters. The spicules, displayed

at the meeting, make admirable microscopic objects, easily prepared, and everlasting. All known sponges are marine, except the genus of which the living species then produced is a member. It occurs near St. Martin's Hill, in the vicinity of the Reed Pond, and in several other places down the Stour river, and may be found on posts, sticks, and weeds, in pools and streams, and commonly appears between wind and water.

October 12th.—Mr. Sibert Saunders exhibited lively specimens of *Coryne pusilla*, *Sertularia filicula*, *Alcyonidium parasiticum*, and *Valkeria cuscuta*. Col. Horsley and Mr. Harvey continued their illustrations of the new method of microscopic illumination, and with satisfactory results. Mr. Gulliver gave an Address "On the Objects and Management of Provincial Museums," which is reported in the 'Kentish Gazette,' Oct. 17, 'Land and Water,' Oct. 28, 'Nature,' &c.

October 26th.—The evening was chiefly occupied by Col. Cox's interesting lecture "On Beach Pebbles," including their microscopic structure.

November 9th.—The evening was fully occupied by the most instructive lecture of the Reverend President, Dr. Mitchinson, "On Hypersthene and Amygdaloid," illustrated by numerous specimens collected by him in Skye, and by drawings in water-colours by R. G. Gordon, Esq., Assistant-Master of the King's School.

November 23rd.—Col. Horsley continued his experiments on the effects of different methods of microscopic illumination, especially as regards the appearance of the lines or markings on the valves of *Pleurosigma angulatum*, *P. quadratum*, and *P. hippocampus*, using a quarter-inch object-glass and transmitted light. The results were so remarkable as to throw doubts on the taxonomic value of the current descriptions of the direction of those markings. Thus, in the former two species, the markings appeared either transverse or oblique, according to the direction of the light, so that they could be made to present a transverse course in one light, and a diagonal course in another light, effects that were produced to admiration as often as desired. But in *P. hippocampus* no such effect could be seen; for in this species the lines always appeared transverse and longitudinal, however the light might be managed.

MEMOIRS.

On the DEVELOPMENT *of the* ENAMEL *in the* TEETH *of* MAMMALS, *as illustrated by the various* STAGES *of* GROWTH *demonstrable in the* EVOLUTION *of the* FOURTH MOLAR *of a young* ELEPHANT (ELEPHAS INDICUS), *and of the* INCISOR TEETH *in the* FŒTAL CALF (BOS TAURUS). By GEORGE ROLLESTON, M.D., F.R.S., Linacre Professor of Anatomy and Physiology, Oxford.[1] (With Plates VI and VII.)

A NAKED-EYE examination of a spirit preparation of a developing molar tooth of an elephant, such as is represented in Pl. VI, appears to be sufficient to show that in development the dentine takes precedence of the enamel in the tooth. In such a tooth a certain number of the more anteriorly placed denticles may be seen to be formed of caps of dentine, of a yellowish colour, encrusted, for various distances from their apices downwards, with opaque white deposits of enamel. Posteriorly to the denticles of this composite character, we see a few denticles consisting of dentine alone, upon which no deposition of enamel has as yet taken place; and, most posteriorly of all, we see processes of the dentinal pulp, which, as yet, are devoid of any covering of dentine.

If, in the second place, we proceed to take note of the capsular processes in which the denticles are enclosed, we shall observe that the inner (reflected) surfaces of certain of these capsules are roughened over by deposit, in correspondence with the enamel deposit already noticed on the denticles which they surround. The deposit on the inner surface of the capsule is soft, and consists of cylindriform cells packed closely together, and forming, when their interior surface is looked down upon, a mosaic arrangement by their apposition, whilst in the immediate neighbourhood of their exterior (their still attached) surface numerous blood-vessels are seen ramifying. There can be no doubt that we have here the often-described proximal and, as yet, but imperfectly calcified ends of the enamel-cells, which have broken away

[1] Reprinted from the 'Transactions of the Odontological Society of Great Britain,' by permission of the Council of the Society.

in the preparation from the more thoroughly calcified segments constituting the enamel deposit on the denticles. It is, in fact, the layer which has been supposed to be at once the functionless "membrana præformativa" of Raschkow, and the functionally protective, however otherwise physiologically inert, "*cuticula dentis*," or "Nasmyth's membrane."

If now, in the third place, we take a thin microscopic section of the anterior part of the lower jaw of a fœtal calf (*see* Pl. VII), made in a sagittal direction, so as to show several developing teeth of various ages *in situ*, we are enabled easily to recognise the representatives of the various structures visible to the naked eye in the molar tooth of the elephant, and to harmonize the apparently conflicting statements which have been made as to the relations held by the tissue forming the enamel prisms, on the one hand, to the stellate tissue of the non-vascular enamel organ, and, on the other, to the vascular tooth-capsule. In such a section of a tooth, in which the enamel has already begun to be deposited, we can see (Pl. VII, *c*) the factor of the enamel organ, which is made up of stellate, loosely compacted anastomosing cells, the so-called "spongy substance," occupying or forming a triangular area with the apex upwards. The apex of this triangular space marks the lowest level to which the formation of enamel has advanced in its progress downwards from the summit of the tooth. Above this point, or, in other words, where the formation of the enamel has called for an abundant supply of mineral matter, the non-vascular stellate tissue has disappeared, and allowed the vessels of the tooth-capsule to come into close relation with the enamel-forming cells which draw so largely upon what they contain. Below this point the stellate tissue gradually reassumes its original proportions, and in a section of the lateral portions of the spoon-shaped incisors of the calf it may be seen to pass completely round the calcifying dental pulp from its buccal to its lingual surface. The area occupied by this stellate tissue in Pl. VII corresponds, of course, to the parts of the cavities of the capsular processes of Pl. VI, which lie below the level of the enamel deposit on the denticles; the disappearance of the stellate tissue in the molar of the elephant, and the separation in that preparation of the upper part of the capsule from the deposing enamel, are alike what the Germans call *artefacta*.

Much of what has been advanced in this short paper may be found explicitly or implicitly stated in some one or other of the numerous memoirs or treatises on the development of the teeth which have appeared of late. It is believed, however,

that as yet it has not been recorded that the enamel of the elephant's molar, as also that of the mastodon's, presents the very same decussating arrangement of the inner portion of its enamel which Mr. Tomes has figured ('Phil. Trans.,' 1850, pl. xliv, xlv, xlvi), as noted by him in the Rodentia, less the Leporidæ and Hystricidæ. Thus the rodent affinities of the Proboscidea, which have so often been commented upon, receive a fresh illustration.

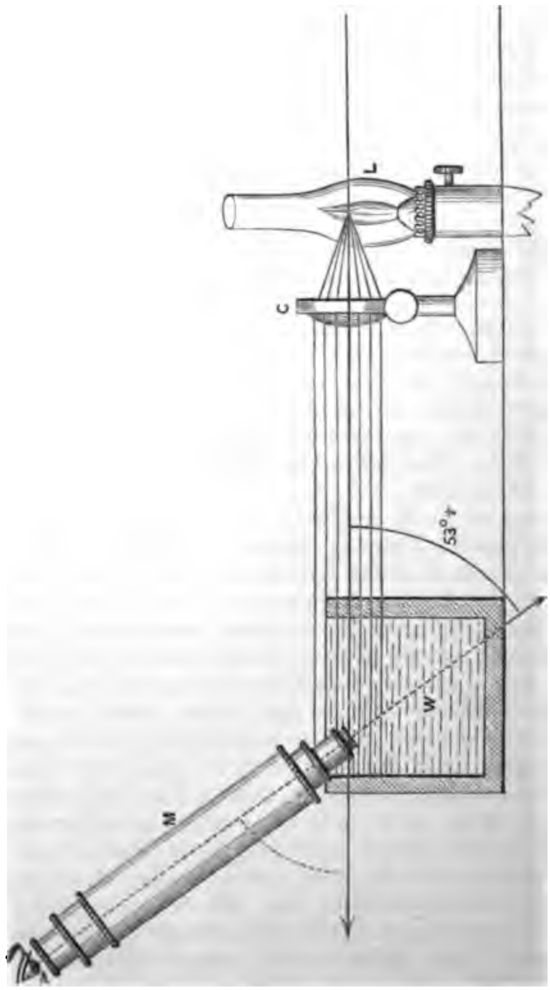
NOTE *on* IMMERSION OBJECT-GLASSES *for the* MICROSCOPE. By Dr. ROYSTON-PIGOTT, M.A., F.C.P.S., F.R.A.S.

IT is a curious fact that, though several writers in this country and America have taken up the question of immersion objectives, very different opinions have been expressed as to the causes of the advantages obtained. One writer boldly asserts that the aperture of an immersion lens can never exceed 80°. The following experiment points to a very different conclusion.

A vessel of glass is filled with water up to the brim; a brilliant paraffin flame is placed at about four feet from it, with its centre at about half an inch below the level of the surface of the water. A lens capable of transmitting parallel rays is then so placed that its focus coincides with the centre of the flame; a beam of parallel rays passes through the plane side of the glass vessel without deviation, in a horizontal direction. The body of a microscope, armed with the immersion object-glass, is then so inclined with the immersion front dipping into the water that the light may just become visible on looking down the tube. The inclination of the axis of the tube or body to the horizon gives the semi-aperture. This was found to be *fifty-three degrees and a half.* The angular aperture of the pencil capable of entering from water into this immersion lens was, therefore, not 80°, but 107°. This clearly depends upon the refractive index of the front glass of the objective, and upon the refractive index of water. This verbal description will be rather more perspicuous by reference to a diagram; L is the lamp; C, the condenser, transmitting parallel rays, without deviation, through the flat side of the vessel of water (W) to the immersed object-glass screwed into the body of the microscope (M), whose semi-aperture was thus found to measure 53° 30′.

But it should be stated that immersion lenses differ con-

siderably in their working angular aperture, although this experiment proves that it may rise to 107°.



Theoretically, if it were possible to construct an object-glass with nearly 180° angular aperture dry, the angle at which the ray would enter from air into the substance of the front glass is limited to about 41° 30′ or 42°, or an angular aperture of from 83° to 84°, according to the nature of the glass.

If we suppose a ray of light reversed, and to travel down the instrument, and after many crooked refractions at last to be traced within the substance of the front lens having a plane front, the limiting angle for the dry lens into air is about 41° or 42°. On entering the stratum of air some extreme rays spread out *nearly horizontally* inwards, and converge to the focal point. But the moment water replaces the air all is changed; none of the rays can possibly be inclined at a greater angle than about 53° to the vertical, the deviation from glass into water being, in this case, about eleven degrees only for the extreme ray.

It is well known that the great difficulty in making a superior objective consists in managing the refractions of the extreme rays striking the front lens of the objective at so wide an angle. In the immersion system no ray ever strikes it at a greater angle of incidence than 53°, whilst in the dry lens it is the highest ambition of the optician to make the extreme ray strike it at nearly 90°, thus giving nearly an angular aperture of 180°.[1]

But it is evident when the angle is limited to 106° or 107° in water the minute spray of rays forming a conical pencil emanating from an illuminated particle find their way *viâ water* into the objective with less violent refractions, and are crowded more thickly into the central areas of the front or facet lenses.

Increased light and brilliancy are effected, as is generally acknowledged. In fact, more rays from a bright particle under observation in the focus of the instrument find their way *viâ water* than can possibly be effected *viâ air*, and pass more centrally up the instrument.

Another statement has been made in reference to immersion lenses, which is entirely erroneous, viz. that the thickness of the covering glass is of no importance when a film of water is above it, as the diminished film of water compensates for a thicker cover. This could only be true if a ray of light passed from glass into water without deviation and without aberration, *i. e.* if the water and glass cover had each the same mean refractive index and the same dispersive powers, which is far from being true.

I have found that in the finest objectives now obtainable the most exquisite definition, even of an immersion lens, depends very sensibly upon having the covering glass of precisely the thickness and *nature* as that for which the glass

[1] The angle of incidence is defined in optics to be the inclination of the ray to the perpendicular to the surface at the point of incidence; here *the axis of the instrument.*

was originally made to work its highest marvels. Amateurs desirous, therefore, of effecting all that the optician desires to be accomplished, should urge him to supply the proper kind of glass cover for which the objective was made. The screw collar is but a rough compensation, at the best, for a variable thickness of glass when the instrument is pressed into extraordinary degrees of amplification, such as 5200 diameters for Powell and Lealand's new immersion one-eighth objective.

There is still a wide field of research open to amateurs and opticians in using other immersion fluids besides water,—a subject upon which the writer has been engaged for some time past.

Observations *on* Pathological Changes *in the* Red Blood-corpuscle. By J. Braxton Hicks, M.D. Lond., F.R.S., &c. (With Plate VIII.)

The numerous observations which have been made within the last ten or twelve years by the means of reagents have done much to elucidate the construction and composition of the red corpuscle of the blood; but it has struck me, as probably it has done others, that these observations fail to satisfy the cravings of the vital pathologist, inasmuch as most of the reagents employed are not of a kind to be found in the body, or likely to come into contact with the corpuscle in the living subject; nor could the physiologist derive any satisfactory information from the effect of these kinds of experiments, because they were diverse from anything likely to be found in the healthy body, so that he could not argue from the effects produced to the ordinary healthy processes. I mean he could not, by them, presume to explain the growth or mode of origin of the red globule—the relationship between it and the white corpuscle or leucocyte. The rapidity of the change which takes place in the blood on leaving the body has always hindered the satisfactory observations which were needful. Some of this difficulty has been overcome by the moist and warm stages, as also by the electrical chambers, whereby vitality and activity are prolonged.

The results of the application of reagents, however, have only supplied us with information upon cadaveric changes. In the living animal, if we except Cohnheim's discovery of

the passage of the globule through the wall of the capillary, but little has been made out to show the alterations of the corpuscle or its origin and formation, or the influence of vital forces on it. Of course, it may be rejoined that many elucidations of the structure of bodies have been arrived at by the means of reagents in a similar manner. This is true, but still, probably, had some of the energy which has been spent on the tracing the changes external to the body, been devoted to observations on the living body, more valuable information would have been yielded us.

It is not pretended that the following remarks will clear up the whole subject. They are merely a slight contribution to our knowledge in this direction, in which it appears to me that it is desirable that observers should continue.

It is many years since the observations which are here below recorded were made. The first in my note-book was in the middle of 1859, the others within a year afterwards. In the mean time the principal amount of what we know on the subject of leucocytes and the red corpuscle has been gained by numerous zealous inquirers, and thus the novelty of the phenomena recorded in them has necessarily been lessened. Yet it is hoped that, made, as they were, on corpuscles which had been for a longer or a shorter time under the influence of the vital forces, though in most instances in abnormal conditions, they possess still some slight value; at any rate they are remarkably confirmatory of what has been subsequently noticed under various modes of investigation.

Observation 1.—My attention was first drawn to the changes in the blood-corpuscles upon observing, on June 17th, 1859, the fluid derived from an ovarian cyst. It was of a kind very commonly found in that growth, namely, of a dark coffee colour. It was examined shortly after, and the different bodies depicted in Pl. VIII, fig. 1, were found in it. The changes in the red corpuscle into the "œcoid" and "zoid" of Brücke are very plainly seen in all stages. First of all, the œcoid is indicated by a transparent centre, and then it is to be seen in all stages of extension from one side or the other. It will be seen, however, that the œcoid is not always single; sometimes it is double, one being extruded from each pole of the red corpuscle. In employing Brücke's two names for the stroma and this clear colourless material, I do so the more easily to distinguish them, not pledging myself as agreeing necessarily with his explanation.

But what was the most interesting in this observation was this, that the small œcoid was set free, and found floating

in the fluid, transparent, but with slightly granular surface. A large number were visible floating about, but it was impossible to say that all were from the same sources. Some, no doubt, were, and from the exact resemblance of those free to those ready to be so one can hardly assign them a different origin. Be this as it may, it was clear that from the stroma of the red corpuscle small, transparent, colourless globular bodies were set free. Their diameter, in this instance, was about the $\frac{1}{10000}$th of an inch. These corpuscles had, doubtless, been effused into the ovarian cyst, and had been exposed to a more natural experiment, and had been in stricter relation with vital forces than when held in microscopical stages. The shape which the "zoid" or stroma more generally assumed was that of a semilunar character, the "œcoid" occupying the cavity.

The fluid was, as before stated, of dark brown colour, of mucous consistence, highly coagulable, and of the sp. gr. 1030. The red blood-corpuscles least changed were about the ordinary size.

Observation 2.—In consequence of the foregoing facts, I instituted an experiment to know what change occurred in the red corpuscle within a small serous vesicle on my hand. I opened it, and found it free from any cells. I then caused a small proportion of blood to flow into it; after a short time (the time, unfortunately, is not mentioned in my notes, but, probably, about half an hour) I found the change represented at fig. 2. It is very like that noticed in the first observation.

Observation 3.—Blood was mixed with the serum from a dead body. The result is not dissimilar to the above observations, the concave and double watch-glass forms being observable (fig. 3).

Observation 4.—Again, in September, 1859, I examined the fluid of an ovarian tumour shortly after tapping, and found the condition of the red corpuscle altered very much; they were found as in the first observations; they are drawn at fig. 4; but transparent globules (œcoids), which are expelled from each, are generally more than one. Three or four were noticed in a few.

The sp. gr. of the fluid was 1025, of mucoid consistence, alkaline. There were many small transparent cellules throughout the fluid, slightly granular on the surface, which were exactly like those seen emerging from the red corpuscles. Besides these were small fat-globules and aggregations of them with albumen.

Observation 5.—Another condition, where the corpuscle

is much under the influences of the vital forces, is that of retained menses. The microscopical appearances I have shown at fig. 5. Masses of the stroma of old corpuscles (zoid) were very readily recognised, aggregating into various sizes, and blood-corpuscles not much altered. Besides these were numerous transparent cellules, of the size and appearance of those extruded from the red corpuscle in the former observations, but there was not sufficient evidence to show how far they were of similar origin, excepting their close resemblance.

Observation 6.—Blood was dropped into fluid drawn from a hydrocele as it flowed. Very shortly (within an hour) it was examined, and the corpuscles showed the appearance of separating into the œcoid and zoid of Brücke very markedly (see fig. 6). The same fluid was examined after ten hours, when the red globules presented the appearance shown in fig. 7; but the "œcoids" were larger than in the earlier observations, being $\frac{1}{4000}$th of an inch diameter.

Observation 7.—When blood-globules had been in contact with mucus of the mouth and vagina, I find in two instances that they were merely stellate, but extruded no transparent cellules.

Those acquainted with the action of reagents will be able to compare their effects with the results of the action of the various fluids in which the red corpuscles were placed. They seem to confirm the observations of others, which point to two constituent parts. That these are both of them in a plastic state seems to be shown by these as well as by many other phenomena; that they are composed of material rather in a condition of "formative" than formed; that no distinct cell-wall, properly so called, exists.

Whether the small bodies shed from them under various abnormal conditions are merely a sign of dissolution, or whether, under close contact with vital forces, they are capable of becoming something more definite, assisting to form the tissues, or even growing into the red corpuscle, yet remains to be seen. The experiments necessary must be difficult to carry out, and must consume much time; still, it is now rather in this direction we must turn, assisted by the light already shed by so many observers, as is well shown in your last number by one of the Editors of this Journal.

On the ARTIFICIAL PRODUCTION *of some of the principal* ORGANIC CALCAREOUS FORMATIONS. By Professor HARTING, of the University of Utrecht. (Preliminary communication.)[1]

THE following pages contain only an abridged report[2] of a series of researches, undertaken with the view of producing, independently of living organisms, certain calcareous formations, which are met with in animals as integral parts of their skeleton, and this by causing calcium carbonate and phosphate to combine, *in the nascent state,* with organic substances.

An essential condition of attaining this end is to follow nature as precisely as possible in the tranquillity and slowness of her operations. This result may be obtained by placing in the liquid containing the organic matter, with which the calcareous salts, as soon as formed, are expected to combine, salts which by their double decomposition produce insoluble salts of calcium.

With this object the salts, in the solid state, are placed in the liquid at a certain distance one from another, either free to mix or else separated by a membrane. The liquids employed were albumen, solution of gelatine, a mixture of these two substances, blood, bile, mucus from *Arion rufus,* tissue of the umbrella of *Aurelia aurita,* and, finally, the liquor obtained by triturating chopped-up oysters in a mortar.

The salts which were intended by their mutual reaction to produce insoluble calcareous salts were, on the one hand, calcium chloride, calcium nitrate, calcium acetate, magnesium chloride, and magnesium sulphate; and, on the other hand, sodium bicarbonate, potassium carbonate, sodium phosphate, and ammonium phosphate.

It is clear, from the method in which the experiments were conducted, that the mixture of salts could only be effected with extreme slowness and by diffusion. Thus, several weeks elapse, in most cases, before the formation of the calcareous combinations is completed and the experiment terminated.

By this method a considerable number of forms are de-

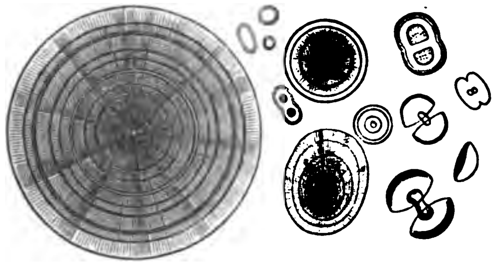
[1] Translated into French from the Dutch original by Professor Edouard Van Beneden, and communicated by the translator.

[2] A detailed description will be given in a memoir which is about to appear in the publications of the Royal Academy of Amsterdam. It will be shortly sent to press under the title of 'Researches in Synthetical Morphology, on the Artificial Production of Some Organic Calcareous Formations.'

veloped, which are, for the most part, found in organic nature. The most frequently occurring form affected by calcium carbonate, in combination with albumen, gelatine, or the other organic substances above mentioned, we will christen *Calcospherites* (Fig 1).

When the calcospherites are formed in the midst of the

FIG. 1.



liquid, and the surrounding parts are perfectly tranquil, they are perfectly spherical. The dimensions they attain may vary from $\frac{1}{500}$th to $\frac{1}{5}$th of a millimètre; they become larger in proportion as their formation takes place with greater tranquillity and slowness. The calcospherites often contain a nucleus, and all those which attain a certain size are seen to be formed of concentric layers and very fine radiating fibres. Similar calcospherites, of spheroidal shape, are met with in nature, in the form of different concretions developed in the bile, the urine, and the saliva of certain animals. What is called "brain sand" of the pineal gland and of the choroid plexus is made up of calcospherites; the otoliths of certain molluscs, worms, and fishes, are calcospherites; finally, pearls are calcospherites, which in the course of time have attained remarkable dimensions.

If the state of equilibrium in the surrounding fluid is not perfect the calcospherites undergo, in the course of their development, transformations, in consequence of which their form is more or less modified. Under these conditions they may become ellipsoidal, oval, or lenticular bodies. One very remarkable form is that which we have distinguished by the name *conostat* (Fig. 2). It is characterised by the presence of a cup- or goblet-shaped enlargement, which becomes filled with air; and by this, as by a sort of hydrostatic apparatus, the hemispherical calcospherite is preserved floating.

The most remakable of all the conditions, which assist in determining the shape of the calcospherites, consists in the

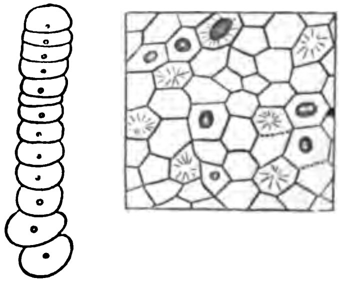
fact of their mutual adhesion, when they are developed in the neighbourhood of one another. The most simple case is that

FIG. 2.

of those double bodies (*dumb-bells,* Fig. 1) which are often produced in very large quantities, and which, as well as the lenticular calcospherites, recall the coccolithes and cyatholithes of *Bathybius.* Agglomerations of calcospherites, in more or less considerable groups (Fig. 3, A), or sometimes in plates

FIG. 3.

A B



(Fig. 3, B), may, moreover, be formed in different manners, and in this way polyhedric bodies are developed, which, so far as their shape is concerned, have a great resemblance to cells. Thus may be explained, also, the structure of the external layer of the shells of various Lamellibranchiata, and of some Gasteropoda, which are apparently composed of cells arranged in columns.

In certain definite circumstances the calcium carbonate, combined with albumen, forms very thin curved laminæ, which have nothing in common with calcospherites, and precisely resemble the calcareous plates of the bone of the sepia. At the same time they enable us to understand the mode of development of other amorphous calcareous plates, and especially those of the shells of Foraminifera and the loculi of the Bryozoa.

The calcospherites consist, as do the laminæ of which we have just spoken, of a combination of calcium carbonate with organic matter, which is the sole residue, when the calcareous salt is removed by treating with an acid. If the development have taken place in albumen, or a liquid containing albumen, the fundamental organic substance remains with the form and structure of the primitive calcareous bodies; but this fundamental substance is no longer albumen. The albumen is transformed into a substance, the chemical reactions of which are those of conchyoline, and resemble those of chitine. We will call it *calcoglobuline.*

It is not, however, necessary, in order to obtain this substance, to cause albumen to combine with calcium carbonate, and then to decompose the resulting compound. This roundabout way may be avoided by placing a fragment of chloride of calcium in albumen. After some days the albumen dissolves the calcareous salt, and is transformed into calcoglobuline, which presents also, in part, a fibrillar structure, and, after having been washed, gives all the reactions of that substance.

When calcium phosphate is liberated by the double decomposition of calcium chloride and neutral sodium phosphate or ammonium phosphate, in a solution of albumen or gelatine, no combination takes place with the organic matter; the precipitate formed consists entirely of crystals of neutral calcium phosphate. The case is quite different if calcium carbonate is at the same time produced in the liquid. The precipitate then consists of a combination of the organic matter with the two calcareous salts. If the calcium phosphate exists in large quantity, then the precipitate remains, even after several weeks, in the amorphous or colloid state. Neither crystals nor calcospherites are formed; but if, on the contrary, the calcium phosphate constitutes nothing more than a small fraction of the precipitate, calcospherites are formed, but among them are some which are the starting-point of various ulterior formations. These may be reduced to two fundamental forms, which, under certain definite circumstances, appear more or less perfectly developed. The first form consists of plates, which sometimes attain a considerable size, and are more or less curved. These plates are either perfectly homogeneous, or else they show fine fibres, sometimes disposed in a parallel manner, sometimes divergent, and concentric bands (Fig. 4). Plates of this kind have precisely the conformation of the calcareous substance which constitutes the internal layer of the shell of the Lamellibranchiata, and which almost always forms exclusively the

shell of the Gasteropoda. On other plates may be observed thickened patches, arranged in parallel bands, similar in

FIG. 4.

appearance to those which exist on the external layer of the scales of osseous fishes (Fig. 5, *a*).

In order to obtain these different forms of plates it is necessary to make use of albumen. Under the influence of a low and constant temperature there are developed, both on the calcospherites and on the plates, curved spinous projections (Fig. 5, *b*). If the liquid contains, in addition, gelatine, other projections are developed upon many of the calcospherites; but they then have a warty appearance, and themselves have upon them secondary smaller projections, or else they branch, till at length they come to resemble, precisely, the spicules or sclerites of Alcyonaria (fig. 6, A). Sclerites of the same

FIG. 5.

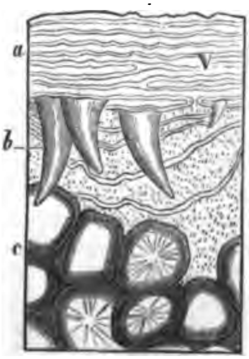
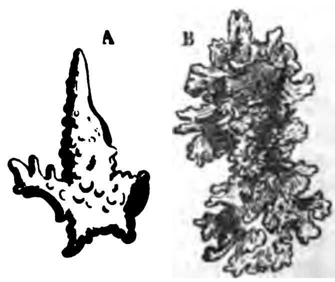


FIG. 6.



kind, although slightly different in form (Fig. 6, B), are also developed in cartilage, which is first impregnated with a solution of calcium chloride, and then placed in a solution of potassium carbonate, mixed with a little sodium phosphate.

The formation commences in the interior of the cellular capsules of the cartilage, and then extends also into the fundamental intercapsular substance.

All these calcareous formations become charged also with organic colouring matters, whether naturally contained in the liquid or purposely dissolved in it. Not only colours of animal origin, but also those from vegetable sources, such as saffron, turnsole, logwood, &c., are absorbed, so that the coloured calcareous formations met with in animals may thus be reproduced.

On the Peripheral Distribution *of* Non-medullated Nerve-fibres. By Dr. E. Klein. (With Plate IX.)

Part III.

In the second part of this memoir we have described, among other subjects, the distribution of fine non-medullated nerve-fibres on the capillaries of the nictitating membrane as well as of the mesentery of the frog.

We there saw how from the large non-medullated nerve-fibres still provided with a nucleated sheath, which accompany the vessel for a longer or a shorter distance, finer nerve-fibres spring off and join to form a plexus round the capillary vessel; further, we were able to follow from this plexus still finer nerve-fibres which partly run in the wall of the vessel itself, in which wall they divide and join by their lateral branches so as to form a network.

What I am going to treat of in this third part will concern first the relation of the non-medullated nerve-fibres to small arteries, small veins, and to capillary vessels, in the muscular substance of the frog's tongue; and secondly, the termination of nerve-fibres in the already mentioned ciliated duct in the tail of the rabbit.

A. *Nerves of the Blood-vessels in the Frog's Tongue.*

The preparations figured in Pl. IX, figs. 1, 2, and 3, were obtained by the following process:—The whole tongue of the living frog is cut out. It is then pinned out on a piece of flat cork, from which it is raised slightly like a tent so as completely to remove its lower surface from the cork, and immersed in half per cent. solution of chloride of gold for

one hour; after that time the tongue is rinsed in distilled water, taken off from the cork and exposed in distilled water to the light until it becomes dark. The tongue is then placed in common alcohol for twenty-four or forty-eight hours, a sufficient time to harden it so far as to be able to make horizontal sections. The sections after they have been washed in water are mounted in glycerine. The preparations which I am going to describe belong to the deeper muscular portions of the tongue. The muscular fibres appear here grayish violet, the connective-tissue-corpuscles, well known by their bizarre shape, are, except the nucleus, dark coloured, the non-medullated nerve-fibres appear dark violet, and the blood-vessels more or less a grayish violet colour. In the intermuscular connective-tissue, which contains a great number of connective-tissue-corpuscles, we find some isolated medullated nerve-fibres provided with a thick nucleated sheath of Schwann. From these spring off more or less numerous non-medullated nerve-fibres which are also provided with nuclei. These nerve-fibres join so as to make a not very dense plexus. If we follow a very small artery (fig. 1), we find a broad non-medullated nucleated nerve-fibre approaching the vessel and accompanying it either without branching, or else dividing into two nucleated branches which are still to be regarded as coarse nerve-fibres.

The two branches accompany the artery for a shorter or longer distance on opposite sides, and bend round the vessel once or twice. Or we see a coarse non-medullated nucleated nerve-fibre crossing the artery, and while doing so giving off two branches which bear the same relation to the vessel as above.

Besides these coarser nerve-fibres which accompany the artery we find a great number of finer fibres which accompany the vessel. They bend round the vessel several times, and join by lateral branches together, forming a plexus which surrounds the artery like a sheath. There cannot be any doubt that the fibres just mentioned are nerve-fibres. First of all they can be traced with the greatest certainty to the above-mentioned coarser nucleated non-medullated nerve-fibres; and secondly, many of them exhibit in their course here and there a nucleated swelling.

To recapitulate, we see that from the coarser nucleated non-medullated nerve-fibres which accompany an artery, there spring off a number of finer nerve-fibres still provided with rare nuclei, which finer fibres form a rather dense plexus like a perivascular sheath. Where this perivascular nervous sheath is very richly developed, and the wall of the artery

is not too much coloured, we are able to follow from this nervous sheath finer fibrillæ which no longer exhibit nuclei, and these fibrillæ can be traced in the wall of the vessel itself, where one or other of them divides into two branches.

In some cases I was able to convince myself of the fact that these very fine fibrillæ join by their branches, as I have already described in the second part. The number of fine nerve-fibres surrounding the vessels in some places, where a small artery divides into two branches, which very soon after that are not easily to be distinguished from capillary vessels, is most striking. This is especially the case when we have to do with arteries so small that only here and there can we distinguish a very limited number of smooth muscular fibres, while, on the other hand, in the larger arteries which possess a distinct middle coat of smooth muscular fibres, the number of the accompanying nerve-fibres can be by no means compared with those mentioned above. As regards the finer nerve-fibres of the capillary vessels I need not trouble the reader with a long description, as I have dealt with this question already in the second part. On the capillaries of the muscular tissue of the frog's tongue I have seen these relations with such distinctness and so plainly that I do not hesitate one moment to adhere to every point I have maintained. I refer to the fig. 3 of this third part:—(*a*) represents a capillary vessel, (*b*) the coarse nucleated nerve-fibres which, as may be seen, have a parallel course with the vessel, and bend round the latter in opposite direction. From these spring off (*c*) finer nerve-fibres which are scarcely provided with nuclei, and which form a plexus round the vessel like a sheath. From this plexus spring off (*d*) still finer fibrillæ which belong partly to the wall of the vessel itself.[1]

[1] If we compare our Fig. 3 with the figures given by Dr. Beale in his last paper on this subject ('Monthly Microscopical Journal,' Jan., 1872, Plate IV, fig. 3 and 4), the substance of which had already been published by the same investigator, who really was the first to mention non-medullated nerves on the capillary vessels several years since ('Philosoph. Transact.,' 1863, pl. lx, fig. 44; 'Philosoph. Transact.,' 1865, pl. xxii, fig. 15; 'How to Work with the Microscope,' 4th edit., 1868, pl. xxix, fig. 192), everybody, even if not thoroughly acquainted with this subject, will, I think, agree with me that the difference between the results which Beale has obtained and my own is not a small one. This difference consists chiefly in the fact that Beale's "ultimate nerve-fibres" correspond to my *coarser* non-medullated nerve fibres, as regards which I perfectly agree with Beale that they accompany the vessel in a nearly parallel course and bend round it once or twice. These nerve-fibres have been seen also by Kessel and Tomsa, as I have already mentioned in the second part. What Beale has not seen at any time in his preparations, and therefore doubts, is the great number of finer nerve-

B. *The Ciliated Duct in the Rabbit's Tail.*

I am unable at present to add much to what I have already published on this subject in my preliminary communication in the 'Centralblatt für Medicin. Wissenschaften,' 1871, No. 38.

If we cut off the tail of young or middle-sized rabbits near the root, strip off the skin, and then tear off the joints nearest the root from the rest of the tail (a well-known method of isolating the delicate tendons of the tail), we often succeed in isolating also what appears to the naked eye as a yellowish cord, extending for nearly the whole length of the tail.

Under the microscope this is seen to be a duct, forming, in all probability, a prolongation of the central canal of the

fibres which spring off from the coarser ones, and which make a perivascular plexus, and further, the still finer fibres which spring off from this plexus. If Beale with his "ultimate nerve-fibres," which I regard, as I have just now stated, only as coarser nerve-fibres, deduces conclusions about the action of nerves on the blood-vessels; if Beale, while building theories, sets aside all the most accomplished and laborious physiological researches of foreign observers, I must pass that over, because I cannot follow him without coming into collision with what has really been found to be the result of experiments. Neither shall I discuss what Beale states about the structure of the capillary vessels; if Beale still adheres, only in a more refined sense, to the description first given by Henle, 1841 ('Allgemeine Anatomie,' p. 491), that also I pass by with great equanimity, the more so as our knowledge of the structure of the capillary vessels has been brought by the numerous researches of German histologists to such a point that the old view of Henle must be regarded as a complete anachronism. Further, if Beale with his method is not able to show anything more about the anatomical relations of the finer nerve-fibres than what he was already acquainted with several years ago, and if he confesses that he is not able by his own method to form any opinion about the assertions of other investigators obtained by a different method—viz. by chloride of gold—and, therefore, doubts them; I should be the last to make any objection except by putting the facts obtained by one method against the results of the other. If Beale, when expressing these doubts, both orally and in writing, calls attention to the fact that the non-medullated nerves of the capillaries have been until lately entirely passed over, I can only perfectly agree with him, especially since Beale, as I stated above, many years since on several occasions described and illustrated them by very beautiful figures. But, on the other hand, I must allow myself to contradict Beale if he asserts that the doctrine of terminal networks of non-medullated nerve-fibres in general was, before him, unknown in Germany, and that the networks of non-medullated nerve-fibres *which he has described* are now accepted, as I have been able to convince myself that, although the doctrine of networks of non-medullated nerve-fibres has been advanced by his researches in a very high and remarkable degree, our knowledge of networks of non-medullated nerve-fibres in many organs has had a different source than he has stated. (See my memoir in the 'Month. Micr. Journ.,' April.)

spinal cord. The wall of this duct consists of the following parts:

a. A pale epithelium, occupying about two thirds of the thickness of the wall, consisting of an internal superficial layer, turned towards the lumen of the duct, of pale, thin, conical, cylindrical cells, and a deeper layer of smaller, apparently round cells, in which there is often only a very narrow zone of protoplasm surrounding the relatively large nucleus. The cells of the superficial layer are all provided with bundles of cilia, which I have seen continue in lively motion for more than three hours in specimens examined in fresh serum.

b. The membrana propria, next to the epithelium, consists of connective tissue with numerous elastic fibres.

c. Most externally is a loose adventitia, in which is a network of remarkably large, richly branched pigment-cells, and which contains the large blood-vessels and lymphatics.

The capillary blood-vessels form a network with elongated meshes, in the propria immediately under the epithelium. Near the duct run large nerve-trunks of medullated fibres, which are connected at the root of the tail by smaller branches, and are provided with remarkably distinct ganglia. (ganglia coccygea, *vid.* Krause 'Anatomie des Kaninchens'). The ganglionic cells of these latter are mostly unipolar, their processes becoming surrounded by a medullary sheath immediately after their origin. The ganglionic cells are mostly each furnished with a capsule, but occasionally we find two, three, or four, enclosed in a common capsule.

I believe that I have also recognised spiral fibres.

In their further course the nerve-trunks wind spirally around the duct, contain here and there small ganglionic enlargements, and give off numerous small branches, consisting of only a few medullated fibres; these last lie loosely side by side in their sheath, and enter the propria. Here they separate from each other and for a short distance have a course parallel to the longitudinal axis; they show here and there swellings and varicosities of the medulla, giving them the appearance of varicose fibres. They divide freely, the thin branches being still always furnished with a dark border.

Finally, these last divide into several thin pale fibrils, the medulla having just previously ceased quite suddenly.

Of these last pale fibres some are in connection with large cells which lie immediately under the epithelium, and possess a relatively large vesicular nucleus, in which is a shining nucleolus, resembling perfectly the nuclei of those ganglionic

cells which we mentioned as being found in the nerve-trunks.

But in serum preparations and also in those treated with dilute acetic acid we can see that most of the pale fibres pass into a coarse network, in many places widened out into a plate-like formation, in whose oblong or rounded meshes the deep epithelial cells lie imbedded. Whether this network becomes identified with the intercellular substance of the superficial cylindrical cells, or whether it is connected with these cells themselves, as has been described by Exner (38) in the pituitary membrane of the frog, I am not yet in a position to determine.

As regards the relations of the network of pale fibres, I must refer the reader to figs. 4 A, and 4 B.

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31. Tomsa, loc. cit.
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On the STRUCTURE *of* TENDON. By J. MITCHELL BRUCE, M.A., M.B. Lond., Demonstrator of Practical Physiology, Charing Cross Hospital Medical School, &c. (With Plate X.)

THE doctrine of the structure of tendon has entered upon a perfectly new phase since the publication of Ranvier's celebrated paper on the subject.[1] In this paper Ranvier describes the tendon of the tail of the rat as consisting of bundles of fibrillar connective tissue, between which regular hollow cylinders are imbedded. These cylinders are built up of quadrilateral nucleated cell-plates, each of which forms an element of the cylinder by being rolled up until its two opposite meet; or, conversely, each element of the cylinder, when opened out, represents a quadrilateral cell-plate. This conception on the part of Ranvier of the arrangement of the cells in tendon is, therefore, completely different from those of former histologists, the majority of whom held that the cellular elements found lying between the bundles of tendon represent spindle-shaped nucleated cells; his description was accordingly very variously received.

[1] *Ranvier*, 'Arch. de Physiologie,' 1869, ii, 471.

Schweigger Seidel[1] accepted it evidently without further minute investigation. Fleming[2] did the same. Bizzozero and Güterbock, on the other hand, contradicted it. Bizzozero[3] described the cells of the tendon as branched, flattened, oblong, and nucleated elements, standing with their long axis parallel to that of the bundles. Güterbock[4] looked upon the bundles as having between them chains of staff-shaped nucleated cells.

Quite recently, in a treatise on the subject of considerable extent,[5] Boll has contradicted every previous view, both older and more recent, *i. e.* both before and after Ranvier, but more especially that of this histologist, whose opinion on the cellular structure of tendon he has essentially disproved.

It is unnecessary for me in this paper to go back and speak of the more precise opinions of the older authorities on the subject, as this has been already most fully done by Boll, to whose work I accordingly refer my readers. The views of this histologist himself, however, I shall consider at some length.

In the embryonal tendon of the diaphragm Boll describes the cellular elements as granular, elastic, quadrilateral plates (in the adult they are the same, but homogeneous instead of granular); these are arranged in a row behind each other, and are bent to correspond to the tendon bundles. Besides possessing the above characters, each plate is furnished with a median stripe, which Boll calls the "elastic stripe;" it occupies the whole longitudinal section of the cell running parallel to the long axis of the bundles, and is, according to its describer, a thickening of the cell-substance, than the rest of which it accordingly appears more deeply coloured when stained with carmine. It is evident that a row of cell-plates will give a corresponding row of such stripes, that is, a continuous stripe; and this "elastic" stripe will assume a straight or wavy appearance varying with the condition of relaxation of the tendon.

[1] *Schweigger Seidel*, "Ueber die Grundsubstanz und die Zellen der Hornhaut des Auges." 'Arbeiten aus der Physiol. Anstalt zu Leipzig,' 1869, p. 144.

[2] *Fleming*, "Ueber Bildung und Rückbildung der Fettzelle im Bindegewebe." 'Max Schultze's Archiv,' vii Bd., 1 Heft, p. 39.

[3] *Bizzozero*, "Sulla Struttura del Tessuto Tendino," estratto dal Morgagni, 'Ueber den Bau des Sehnengewebes.' (See 'Quart. Chron. of Histology.')

[4] *Güterbock*, "Zur Lehre von den Bindegewebskörperchen in den Sehnen." 'Centralblatt,' 1870, No. 3, p. 33.

[5] *Boll*, "Untersuchungen über den Bau und die Entwickelung der Gewebe." 'Max Schultze's Archiv,' vii Bd., 4 Heft, p. 275.

The material which I have made use of in studying the structure of tendon, is that to be found in the tail of young and grown rats, as well as in the tail of the young rabbit, and the results which I have arrived at on the subject will be found in some respects to agree, in some respects to disagree, with those obtained by Boll.

In the first place, following Ranvier's method, I removed the tail of a young rat or rabbit, isolated the very fine tendons contained in it, and mounted specimens of them in a drop of fresh serum. Here I found numerous tendons, consisting of wavy bundles which cross each other, as well as a smaller number of tendons composed of bundles which were straight or wavy, but parallel, and of a homogeneous appearance. When I now used a greater magnifying power (over 400), and carefully observed such a tendon, there came into view, a short time after the specimen was mounted, peculiar systems of clear lines. There were, indeed, to be seen, from place to place in the various depths of the tendon, but especially near its surface, groups of shorter or longer clear lines which were arranged transversely to the long axis of the bundle, while their length did not exceed the breadth of a bundle, and they were placed in every case so as to form the boundaries of spaces of equal breadth. In some places these clear transverse lines were limited to the alternate bundles; on the most superficial bundles, however, they were found upon two or three neighbouring ones, in which case they were united at the conjoined border of two contiguous bundles by a longitudinal line corresponding to it, so that two or three contiguous superficial bundles appeared at such places as if covered with a mosaic, mainly of quadrilateral plates.

I next added very cautiously to such a specimen a dilute solution of acetic acid; the spaces so defined then became distinctly granular, and within them there came gradually into view a roundish nucleus, while the lines uniting the cells mutually in contact lost the clear appearance they possessed in the fresh state and became dark. In addition to the nuclei mentioned there appeared on many other places rows of oblong or staff-shaped nuclei lying imbedded in a very limited clear rectangular space, each pair of nuclei being separated by a short transverse line.

When the action of the acetic acid was increased in intensity, either by increased strength of the reagent or by its more prolonged application, a different and highly significant appearance was found to be produced. While the tendinous bundles became considerably swollen and transparent, the quadrilateral plates became increased distinctly in breadth,

and presented at their lateral margins, not a straight optical line, but an irregular ragged border.

Such are the appearances presented by a fresh tendon where the bundles are not parallel. I shall not as yet draw any conclusion from them, but describe in the next place the results obtained by other processes.

Of these, the first I availed myself of was the one with nitrate of silver. The fine tendons from the tail of the rat were removed with care, and allowed to remain in a half-per-cent. solution of the salt for two or three minutes, then transferred to a vessel of water placed in a bright sun, and when coloured mounted as usual. Specimens of tendon so prepared presented on examination a very fine superficial layer of large polyhedral endothelial plates, the dark connecting lines of which were more or less tortuous. In some of the specimens where this endothelium was slightly marked, or where it had been removed, either accidentally or by gentle pencilling in serum with a camel's hair brush, before the specimen was put into the silver solution, there was to be seen evidently close under the endothelium of the surface a system of clear branched spaces (*Saftkanälchen*) on a yellowish brown ground. Yet another or third appearance was frequently found on the silver specimens in the deeper parts of the tendon; in many of them prepared as above described only here and there, but much more extensively and distinctly if the pencilling process had been resorted to, and the brush used with considerable freedom. This third appearance fully corresponded to that found in the fresh tendon. The parallel course of the bundles was seen, as before, interrupted by regularly disposed transverse lines, the only difference in the two cases being that the lines were in these silver preparations dark instead of clear, and the surface of the bundles—that is, the quadrilateral spaces bounded longitudinally by the lines—clear instead of dark. In these specimens, also, as in the fresh ones, the transverse lines of two or three neighbouring bundles were frequently found to be continuous with each other laterally. The arrangement, therefore, exactly corresponded in the specimen prepared by the two processes. In some parts of the preparation a similar terminal junction of the transverse lines could be made out without difficulty at some depth beneath the surface of the bundles.

The next method of preparation which I made use of was that with chloride of gold. Tendons from the same source as before were allowed to remain in a half-per-cent. solution of the salt until they assumed a bright straw colour, on an

average, for half an hour, and the process completed as usual.

When this method was quite successful, the specimens obtained by it were exceedingly beautiful and highly instructive. The tendon bundles were found covered by alternate rows of large cells, quadrilateral in shape, possessing a large roundish nucleus usually terminally situated (see fig. 1), and a bright nucleolus, and disposed, as I have said, on the surface of the bundles, as was fully proved by the examination of carefully teased specimens. When these were successfully obtained, two or three isolated bundles were sometimes to be found lying beside each other, but not actually in contact, on which there was distinctly present a superficial cellular covering, in one on the upper surface, in a second on the under surface, and in a third bundle laterally disposed (that is, seen in profile as rows of thin oblong cells), while they plainly bent around the bundle, that is, covered a larger area than was indicated by their nucleus and the thickened protoplasm surrounding it.

A modification of the gold method is a combination of it with the acetic acid one. The tendons are first slightly swelled in a dilute acetic acid solution and then subjected to the gold process as before. The results thus obtained agreed exactly with those derived from the simple acetic acid process, but the appearances were more distinct, from the cells being coloured of the usual purple.

Individual tendons, after either the acetic acid or the combined acetic acid and gold method, frequently exhibit a sheath which in such preparations has an almost structureless appearance; in it there are however found occasional fine longitudinal lines, as if made by fibres. This sheath surrounds the fibre bundles, and consequently corresponds in position to the system of branched spaces which I have described as occurring in the silver specimens, and which must be distributed in the substance of the sheath.

Specimens which will yield appearances in every respect confirmatory of those already obtained, and in some respects supplementary to them, may be made by combining the silver and gold methods. The tendon is bathed in silver as usual, after or without pencilling in serum, slightly washed in water, and then transferred to the gold solution for fifteen minutes; the further preparation is not peculiar.

In studying the structure of the tendons of the tail of the *adult rat*, I again availed myself of the various methods of preparation which I have described. Of these, I found it was the silver process that yielded the most instructive spe-

cimens. On such a preparation it was only here and there that an appearance similar to that in the growing tendon was to be seen, namely, rows of rectangular spaces upon the fibre-bundles; these were replaced in the adult tendon by others, which, while more or less distinctly oblong, were also variously branched. Between these two forms there occurred, however, also many intermediate ones; that is, places were found where the linearly arranged quadrilateral spaces preserved their young characters, except that their borders were notched instead of straight, while in other parts this irregularity was so marked that distinct processes were found uniting the spaces to each other lengthwise. When the spaces happened to be viewed in profile or half profile, they were seen to be connected laterally also by such processes.

From what I have written it will be plain that I accept completely the views of Boll on the relation of the cells to the fibrillar bundles, a view which may be thus briefly expressed.—The cell elements in the young tendon are plates so arranged as to bend round the fibrillar bundles, and consist of a granular protoplasm enclosing a clear roundish nucleus, the depth of the protoplasm being greatest at the place where the nucleus is situated, and gradually diminishing outwards thence. The cell-plates are of uniform or nearly uniform size, and are bound to each other by intermediate cementing substance, both in the line corresponding to the longitudinal axis of the tendon and in that corresponding to its transverse. Thus, the individual cells in a tendon build by their union a connected whole. This system of cell-plates might be very aptly likened to a cloth composed of a number of stripes. Each stripe consists of a sum of plates of the form of a parallelopipedon, the longitudinal axis of which is at right angles to the longitudinal axis of the stripe; the nucleus of each plate lies in the middle line of the stripe, but near one of the short sides, and generally so that the nuclei of two neighbouring bundles are either as near each other or as far from each other as possible. Let us further conceive the fibril-bundles so enveloped in this cloth that each is surrounded to the extent of half its circumference by one stripe. We should then find all the appearances such as are to be found in the tendon at various depths, in which the stripe would cover the upper half or the under half, the right half or the left half of *its own* bundle, as well as all the intermediate views according to the degree of obliquity.

It is well known that in the growth of the tendon the fibril-bundles increase both in length and thickness, in length decidedly more than in thickness. Bearing this in mind, let

us note several other points in the anatomy of the tendon—first, that the young tendon possesses relatively more cells than the adult one; secondly, that the length of the cell-plate in the adult tendon usually exceeds their breadth; and lastly, that in the adult tendon the cell-plates are more branched in the direction of the long axis of the bundles than in the transverse one. Putting these facts together, I believe I am justified in assuming that in the growth of the fibril-bundles in length and thickness, the cell-plates become removed from each other, yet continue their mutual connection by communicating processes corresponding to the prevailing growth of the fibril-bundle; the cell-plates will also be longer than broad, and will similarly come to possess longer processes in the long axis of the tendon than in the other.

But it must be stated that during the growth of the fibril-bundles there is another change in the cell-plates besides that which has just been described, which consists in this—that one cell-plate divides into a chain of cell-plates, which, while they gradually separate, remain connected to each other by processes. And it must also be stated, on the other hand, that a cell already branched at the extremities will itself again divide across, and the originating divisions separate. In favour of this view are all those intermediate appearances which we meet with in the half grown and in the adult tendon, viz. cell stripes, in which here and there the individual members, arranged behind each other, stand isolated and branched, as well as places where a row of cell-plates occurs of which only the two terminal ones are branched, and that terminally only, while the others are mutually joined by straight lines.

If Boll makes a distinction between the cells of the growing and of the adult tendon in this respect, that in the former the cells are more protoplasmic in nature than in the latter, where they should be considered as representing elastic plates, then I must say that I cannot agree with him. And if he calls the cells of the tendinous tissue endothelium, then here again I can agree with him only so far as this;—that in the young tendon the cell-plates possess an arrangement which is just comparable to that of endothelium. As for the grown tendon, its cells can be called endothelial only in so far as they represent plates consisting of granular protoplasm, and in some places are less branched and more close to each other—that they only rest in a line like endothelium, and differ in their arrangement in no respect from those cells found in the tissue of the serous membrane of grown animals. (Compare " Preliminary Communication," &c., by Dr. Klein and Dr. Burdon Sanderson, in this Journal, p. 142.

In regard to the "elastic stripe," I cannot agree with Boll at all. In a tendon, when the bundles lie parallel, and the rows of cell-plates present themselves to view from the surface, I do not find anything of a median stripe; but when the row of cell-plates is seen in half profile there is visible on one side of each of them, evidently where it bends round, and therefore is seen from the edge, something which may be compared to the elastic stripe. On the other hand, I must say that on some parts of tendons which do not exhibit the bundles in a parallel disposition, and which are, therefore, to be regarded out of their natural condition, irregular cell-plates are to be found, which, when seen from the surface, exhibit something like a median stripe. In this respect, consequently, I agree with Boll, if it is meant that a folding or a crumpling of the cell-plate may produce the appearance of a median stripe. (Compare Török's "Vorläuf. Mittheil.," 'Centralblatt,' 1872, No. 5, p. 67.)

I come now to deal with the question—have the fibril-bundles of the tendon a sheath? Boll agrees with the older investigators in so far as he assumes with them that the individual bundles are surrounded by a sheath; at least, he assumes it as very probable. And this opinion he has arrived at by studying the appearances presented by transverse sections of tendons. Without being in a position with certainty either to deny the existence of a sheath or the fibril-bundles, or to grant it, I must still mention that it is exactly the appearance of a transverse section that can be satisfactorily explained without accepting the presence of a sheath. If we study, for example, the cross section of a tendon of the tail of the rat from a gold preparation,[1] we observe, what has been held by all authors, that the processes of the stellate figures (which often contain a nucleus very distinctly), break up into branches which reunite in such a manner as to make a network, each mesh of which is occupied by the transverse section of a bundle. This appearance may be easily explained when we reflect that each bundle is ensheathed by nearly a half-cell-cylinder, so that the ring by which the

[1] I have obtained the best and most complete preparations of cross sections of tendons in the following manner:—The distal half of the tail is removed from the living animal, the skin stripped off, and the organ placed in a half-per-cent. solution of chloride of gold for fifteen or twenty-five minutes, after which time it is removed, and exposed to the light in distilled water until it has become coloured. The tail is then placed in a one-tenth or one-eighth-per-cent. solution of chromic acid for two or three days, until the bones become softened, then transferred to alcohol for a quarter or half an hour, and finally imbedded. The sections cut from it should be washed in water and mounted in glycerine.

transverse section of a bundle is surrounded is composed of parts of all cross sections of half-cell-cylinders of the contiguous bundles. Now, should we conclude from the appearances on cross sections that there is a sheath round the bundle, then the meshes of the network ought to be of nearly equal size, because the bundles of a tendon are all of nearly equal thickness. But it is by no means a fact that the meshes of the network seen on cross section are of nearly equal size. On the contrary, on a very successful cross section made from a very successful preparation, they are found to differ mutually in a manner perfectly incompatible with the constant thickness of the bundles. The appearance is, however, readily explained by the fact that many of the bundles touch on the surfaces that are free from cells; to such a *group* of cross-cut bundles the large meshes accordingly correspond, while the small meshes are caused by the contiguous bundles coming in contact with each other by surfaces all completely covered by the cell-mantle. On silver specimens which have been brushed in serum one may occasionally find the surface of the bundles at various depths, which are not covered by rows of cells, exhibiting a finely granular aspect, so that it is not very improbable that there exists between the bundles an albuminous substance in which these precipitations of silver occur.

It has been pointed out by many observers[1] that there exists in the tendo Achillis of the frog, of some mammals, and also in other tendons of the extremities—cartilage—and that either real hyaline cartilage or only cartilage-cells. In respect of the tendo Achillis, Boll distinctly denies the truth of this; for other connective-tissue substances where cartilage has been described among the connective-tissue, he denies it also with more or less distinctness. Quite recently, however, as regards the tendo Achillis of the frog, Boll has been contradicted by Török. And as far as the question concerns the intervertebral discs I must distinctly deny Boll's assertion that the cells in "so-called cartilage" are elastic hyaline cell-plates, exactly as in tendon; and I cannot in any way understand how this observer, who asserts that he has investigated the structure of the tails of rats and rabbits in transverse sections, could have overlooked the cartilage of the intervertebral substance. On a longitudinal section of the tails of these animals we find that the matrix of the intervertebral substance consists of fibrillar bundles, crossing each other at more or less acute angles. The cells upon these bundles as well as between them have

[1] Lehman, Hoyer, Gegenbauer, and Güterbock.

quite the same arrangement as in the perichondrium which comes in contact with it and in the tendon; that is, they are disposed in rows; only the cells here are not bent and not flat, but more or less cubical, consisting of a granular protoplasm colouring readily in gold, and possessing a roundish nucleus. Thus, in fig. 5 we see the fibrillar matrix at *a* passing into the hyaline substance of the cartilage. Here we see also that the regular arrangement of the cells disappears; those to be found on the transition line differ from the ones at *b*, imbedded in the hyaline cartilage, and from those at *c* in the fibrillar matrix, in no respect whatever except that in the last case, where they are lying upon or between fibrillar bundles, they are arranged in a chain-like manner.

In conclusion, I have to acknowledge my deepest obligations to my friend Dr. Klein, without whose assistance during the investigation of the subject, in the preparation of this article, and in the production of the figures that illustrate it, the present paper would have never appeared.

The EMBRYOLOGY *of* CHRYSOPA, *and its* BEARINGS *on the* CLASSIFICATION *of the* NEUROPTERA. By A. S. PACKARD, jun., M.D.[1]

IN a paper presented at the Burlington meeting of the Association in 1867, I gave a brief sketch of the embryology of Diplax, especially in the later stages. Those observations, with the far more carefully elaborated studies of Brandt[2] on Calopteryx, another member of the family Libellulidæ, have made us acquainted with the embryology of the type of one important division of Neuroptera, and now I have to offer a partial history of Chrysopa, the representative of another important division of the group. I did not observe the formation of the blastoderm, but the blastodermic skin ("amnion") of Chrysopa, is of the same structure as in Calopteryx. At the posterior end of the egg the round nucleated cells are crowded together in the same way as in Calopteryx. The primitive band is of the same general form, and floats in the

[1] From the 'American Naturalist,' vol. v, Association Number, September, 1871. (Communicated, with corrections, by the Author.)

[2] 'Beiträge zur Entwicklungsgeschichte der Libelluliden und Hemipteren.' St. Petersburg, 1869.

yolk as in Calopteryx, but more as in Aspidiotus, though it rests more on the outside of the yolk than in those genera, and the end of the abdomen rests on the outside of the yolk, rather than rolled in within the yolk; but that the germ is an endoblast (so far as that condition has any special significance) is shown by the fact that the dorsal side of the primitive band points inwards towards the centre of the yolk, as in the Libellulidæ, the Hemiptera, and a Coleopterous insect (Telephorus), in contradistinction to the Phryganeidæ and the Poduræ (Isotoma), in which the germ or primitive band floats entirely on the outside of the yolk. After the procephalic lobes and rudiments of the appendages of the head and thorax have begun to develop, a second moult (visceral layer) of the blastoderm is made, which envelops the head and under side of the body much as in the Libellulidæ and Hemiptera. At this time the embryo is much like that of the last-named insects. The germ does not revolve in the egg, as in the Libellulidæ, but the head remains throughout embryonic life next the micropyle. At the next stage observed, the appendages of the limbs had appeared, the embryo being situated on the outside of the yolk, the end of the abdomen curved around on the opposite side of the yolk. At this time the inner or "visceral layer," forming a second moult of the blastoderm, envelops the germ, much as in the Libellulidæ, and Hemiptera, and Coleoptera (Telephorus). It is evident that this *faltenblatt* of Weissmann (or visceral layer of Brandt) is shed at a later stage than the "amnion" proper. This stage corresponds with that of Calopteryx figured by Brandt (pl. i, fig. 11). At this time the germ of Diplax and Calopteryx (Libellulidæ) floats within the yolk, but this difference I would regard as having no special importance, as in the Hemiptera the germ at the same stage of development rests on the outside of the yolk in Corixa, while in the Pediculina, according to Melnikow's researches, the germ floats within the yolk, and we shall see farther on that in the Curculionidæ (Attelabus) the germ rests on the outside of the yolk (ectoblast), while that of Telephorus is a decided endoblast, *i.e.* floats in the interior of the yolk. After this period, the embryo of Chrysopa exactly corresponds to that of all the Libellulidæ whose development is known (Agrion, Calopteryx, Perithemis, and Diplax).

The embryogeny of Chrysopa is identical, then, with that of the Libellulidæ. What becomes, therefore, of the distinction between the "Pseudoneuroptera," and "true" Neuroptera, insisted on by some of the leading entomologists, since Erichson's day? Never believing that the differences were

great enough to separate the Linnæan Neuroptera into two independent orders or suborders (whichever we may choose to call them), I now ask if embryology does not give independent testimony as to the close alliance at least of the Libellulidæ and Hemerobidæ, even if we go no farther?

The only Coleoptera with whose development we are acquainted is Donacia, worked out more carefully by Melnikow than any one else. During this summer I have studied *Telephorus fraxini* and *Attelabus rhois* in nearly all their embryonic stages. Attelabus is developed in the same manner as in Donacia. There is a parietal ("amnion") and a visceral membrane in Attelabus; (it was not observed in Telephorus, though it doubtless exists), as in Donacia. In Attelabus, however, the primitive band rests on the outside of the yolk, while in Telephorus it floats in the yolk, and forms a sigmoid band, extending back to the posterior pole of the egg. But after the rudiments of the limbs appear, the embryology of both genera accords with that of Donacia. I have found that the embryology of *Gastrophysa cæruleipennis* in its later stages also agrees with that of Donacia (both being Chrysomelids). A study of the development of *Nematus ventricosus* shows us that its embryology accords with that of *Apis mellifica*. The formation of the blastoderm is as described by Bütschli in Apis,[1] and quite like that of the Formicidæ as studied by Ganin. It also agrees with that of the Diptera in most particulars.

There is indeed a remarkable uniformity in the mode of development of the Hexapoda, as much so, perhaps, as in the Crustacea (Malacostraca), and it is difficult to determine what embryological characters may be set down as distinguishing even the different suborders. These characters, whatever they may be, do not probably reside in the embryonal membranes, or in the relation of the primitive band to the yolk. Perhaps they will be found in the form of the advanced embryos. For example, we now know that the embryos of the Isopod Crustacea only differ from those of the Amphipods while in the egg by having the end of the abdomen bent over the back, while in the latter (Amphipods) it is curved beneath the body, as pointed out by Fritz Müller. The spiders and scorpions also pass through a similar course of development, and the Mites (Acarina) are developed in a manner either identical with the spiders in some genera, or more like the Hexapods in others. We know almost nothing of the embryology of the Myriapods,

[1] Dr. O. Bütschli, "Zur Entwicklungsgeschichte der Biene," 'Siebold und Kölliker's Zeitschrift,' 1870, p. 519.

but Newport's observations on Julus indicate that it is developed in an entirely different mode from the Hexopoda or Arachnida, a remarkable feature being the persistence of the larva in its inner (?) embryonal membrane (*faltenblatt* of Weissmann) for many days after it is hatched.

There are, however, two modes of development in the Hexapoda, depending on the position of the primitive band in relation to the yolk. The Hymenoptera, Diptera, and certain Coleoptera (Curculionidæ), and Donacia, and the Phryganeidæ and Poduræ (Isotoma) are *ectoblasts*,[1] while Telephorus and the Hemiptera and certain Neuroptera (Libellulidæ and Hemerobidæ) are *endoblasts*, to use Dr. Dohrn's terms. On inquiring how far these two modes correspond to the degree of development of the insect on leaving the egg, and the degree of metamorphosis of the insect before becoming adult, it seems that the endoblasts occur in those ametabolous insects (Hemiptera and Neuroptera) with flattened, leptiform larvæ, and also in those Coleoptera with similar larvæ, as distinguished from the weevils, which have eruciform larvæ, *i.e.* resembling the maggots of Diptera and Hymenoptera. The two modes of development, then, do not fully accord with the two different degrees of metamorphosis of insects, but more probably depend simply on the form of the larva when hatched. Now, there are two forms of insect larvæ which are pretty constant. One we may call *leptiform*, from its general resemblance to the larvæ of the mites (Leptus). The larvæ of all the Neuroptera, except those of the Phryganeidæ and Panorpidæ (which are cylindrical and resemble caterpillars), are more or less leptiform, *i.e.* have a flattened or oval body, with large thoracic legs. Such are the larvæ of the Orthoptera and Hemiptera, and the Coleoptera (except the Curculionidæ; possibly the Cerambycidæ and Buprestidæ, which approach the maggot-like form of the larvæ of weevils). On the other hand, taking the caterpillar or bee larva with their cylindrical fleshy bodies, in most respects typical of the larval forms of the Hymenoptera, Lepidoptera and Diptera, as the type of the *eruciform* larva, we find that those insects with such larvæ are ectoblasts. (The Poduræ which, as in Isotoma, are ectoblasts, and are certainly leptiform when hatched, form an apparent exception.) Thus, the two modes of development (ectoblastic or endoblastic) perhaps simply

[1] I omit any reference to the Lepidoptera, which Dr. Dohrn regards as endoblasts, but which I am inclined, from some eggs (probably of an Arctian) I have studied to regard as developing like the Hymenoptera and Diptera.

depend on the form of the insect when hatched, and its mode of life.

The leptiform larvæ of insects may be compared with the nauplius form of Crustacea, and in a much less degree the eruciform to the zoea form. The three higher suborders of insects may be compared to the Malacostraca with their zoeæform larvæ, and the four lower suborders (Coleoptera, Hemiptera, Orthoptera and Neuroptera) with the Entomostraca,[1] in which certain forms, as some Phyllopods, and Limulus, and the Trilobites, are hatched in a subzoea condition (corresponding to the eruciform larvæ among the Neuroptera and Coleoptera). The larvæ of the earliest insects were probably leptiform, and the eruciform condition is consequently an acquired one, as suggested by Fritz Müller.[2] His suggestion, followed up by Brauer, that the insects have descended from some zoea does not seem of much value, as the leptiform larva more exactly parallels the nauplius of the lowest Entomostraca (Copepoda). We have already suggested that the Insects and Crustacea probably arose by two distinct lines of development from the worms, rather than that the Nauplius gave rise to the Insects, as Müller has suggested; an important reason for this view being that the three pairs of appendages of the Nauplius do not homologise with the distinct cephalic and three thoracic appendages of the Leptus.

PRELIMINARY NOTICE *of* RESEARCHES *on the* ANATOMY *of the* SEROUS MEMBRANES *in* NORMAL *and* PATHOLOGICAL CONDITIONS. By DR. E. KLEIN *and* PROFESSOR BURDON SANDERSON.[3]

BEING engaged in the study of secondary inflammations, we propose in the following pages to give briefly the results from an anatomical point of view, to which our investigations have led us. These communications relate, however,

[1] The terms Malacostraca and Entomostraca are used for convenience not that they are entirely natural divisions.

[2] "It is my opinion that the 'incomplete metamorphosis' of the Orthoptera is the primitive one, *inherited* from the original parents of all insects, and the 'complete metamorphosis' of the Coleoptera, Diptera, &c., a subsequently acquired one."—*Für Darwin*, Eng. Trans., p. 121.

[3] Forming a part of investigations on infectious diseases, undertaken for the Medical Department of the Privy Council.—From 'Centralblatt für Med. Wiss.,' 1872, Nos. 2, 3, 4.

only to the serous membranes, to which we have for the present confined our attention; the experimental researches we must leave unnoticed in this place.

Our investigations relate to more than 250 animals, especially rabbits and guinea pigs, many frogs, several cats, dogs, some rats, and one monkey.

I. *The centrum tendineum of the diaphragm.*

(*a*) *Under normal conditions.* The lymphatic vessels of the centrum tendineum are in each half arranged in two systems, an anterior and posterior.

The vessels of the anterior system are distributed upon the outer and anterior (that is, larger) division of the anterior quadrant, and upon the outer (that is, smaller) division of the anterior quadrant. Those of the posterior system are distributed upon the inner posterior (that is, smaller) division of the anterior quadrant, and upon the inner (that is, larger) division of the posterior quadrant.

The efferent trunks of the anterior system course along the *Pars costalis* of the diaphragm, and unite on the posterior surface of the xiphoid cartilage on each side usually to a single large vessel which runs along with the mammary vessels and enters the sternal gland. The efferent trunk of the posterior system is single on each side: it mounts obliquely towards the middle line and opens into the thoracic duct near the point where the latter emerges from the diaghragm. The larger lymphatic vessels of each system run between the serous covering of the pleural side and the pars tendinea. The lymph-capillaries which arise from them and are united together are as follows :—First, winding vessels of various length which are situated between the Pleura and the pars tendinea. Secondly, those which lie partly between the serosa and the pars tendinea, and partly in the latter; and, finally, those which belong wholly to the pars tendinea. Those of the first and second groups show dilatations or sinuses; those of the third group have an extended course and lie imbedded between the tendinous bundles. In the rabbit and the guinea pig there are two such layers of longitudinally extended capillaries corresponding to the two sets of lymphatic fissures described by Ludwig and Schweigger-Seidel, the deep set which are between the circular bundles, and the superficial which are between the radiating bundles of the tendon.

The longitudinally extended capillaries which we will call

vessels of the fissures form the only channels of communication between the anterior and posterior lymphatic systems, Each of these systems communicates with the corresponding one of the other half by means of larger vessels, furnished with valves and lined with spindle-shaped endothelium, which run between the serous covering on the pleural side and the tendinous tissue.

In the neighbourhood of the median line of the anterior quadrant, and in the neighbourhood of the large vessels which pierce the diaphragm, some of the vessels of the fissures unite with some sinuous capillaries forming a network, which like those of the pleural side are dilated into sinuses. These lie more particularly between the serous covering of the abdominal side and the tendinous tissue. In the neighbourhood of the spot just mentioned two of the superficial vessels of the fissures may be seen to be united by a transverse branch belonging to the abdominal serous covering, and this branch is also dilated into sinuses.

All the fissures between the tendinous fasciculi do not contain lymphatic vessels; some, on the other hand, contain only blood-vessels, and others a network of cells, of which more will be said presently. The vessels of the fissures communicate with the free abdominal surface by means of "perpendicular lymph-canals." These are short, for the superficial vessels, longer for those which are situated deeper down. A canal of this kind sometimes passes directly through one of the superficial vessels of the fissures and only opens into a deeper one. The canals are lined at their free orifices, which are *true stomata*, by an endothelium which looks younger than that of the surface, is evidently granular, and nearly cubical. This endothelium is continuous on the one side with the flat endothelium of the vessels of the fissures, on the other side with that of the serous surface. Each of the vessels of the fissures possesses a number of such perpendicular canals, which are arranged in rows one behind the other. Moreover, perpendicular canals of this kind with a free orifice are found not only in connection with the vessels of the fissures, but with the serous lymph-capillaries of the abdominal side as well.

The arrangement of the lymphatic vessels of the centrum tendineum might thus be compared to a pump with two cylinders; the one cylinder corresponding to the pleural vessels of the anterior system, the other to those of the posterior system; while the pipes connecting the two cylinders are represented by the vessels of the fissures, and the piston tube by the perpendicular lymph-canals.

With respect to the endothelium of the lymphatic vessels and capillaries, we have nothing to add to what has been taught by Recklinghausen.

The cellular tissue-elements of the pleural serous membrane are in general flat and branched. Two layers of them may be distinguished; that which is more superficial lies immediately under the endothelium of the surface. The cells are sometimes large flat bodies lying close together so as to be only slightly branched, and appearing to be separated by linear intercellular substance which only here and there forms nodular elevations. In this case, the appearance presented is as if these were under the endothelium of the surface another layer of large flattened endothelial cells. This appearance is met with in the vicinity of the vena cava and aorta as well as in isolated spots of the middle line of the anterior quadrant of the centrum tendineum. On the other hand, the most superficial tissue-cells may sometimes be clearly branched and united by means of their processes. When these two types of formation are in contact, evidently transitional forms may be seen.

The cells of the deeper layer which are imbedded in the tissue of the serosa are smaller than those just mentioned, and are also for the most part flattened and more or less branched. They are connected with the superficial layer at several points. In the vicinity of the lymph-capillaries of the pleural serosa they are often approximated in such a way that they touch each other only in a line, two, three, or four together, or else they are grouped round a common centre. On the side by which they are not in contact with one another, they nevertheless have processes by which they are connected with the neighbouring isolated cells. The nearer, generally speaking, they are to the lymph-capillaries, the less branched and the more closely approximated are they. Finally, they may be seen to be directly continuous with the endothelium of the lymph-capillaries, that is, to stand in direct communication with these vessels. The same relations subsist between the flat, more or less branched cells, situated in the outermost parts of the tendinous fasciculi, and the cell networks found in some of the fissures on the one hand, as well as on the other hand between the former cells and the endothelium of the vessels of the fissures.[1]

The same relations may be demonstrated for the abdominal as for the pleural *serosa*, in places where the former is not perforated by fenestrated openings. For the system of spaces in which the cellular structures already mentioned

[1] See Dr. J. M. Bruce's researches on the "Structure of Tendon," made under the direction of Dr. Klein, in this Journal, p. 129.

are situated, we retain the name proposed by Recklinghausen plasmatic canals (juice-canals, Saftcanälchen), but the cells themselves we will call plasmatic canal-cells, lymph-cells or endothelial cells, names the propriety of which will be established hereafter.

The following close relations exist between the endothelium of the free surfaces and the plasmatic canal-cells; some plasmatic canal-cells may be seen both in the abdominal and the pleural serous surface penetrating between the endothelium with a process, or with a larger or smaller portion of the cell-body which then lies free upon the surface. In the latter case their processes extend between the individual endothelial cells. Where a plasmatic canal-cell pushes out but one process between two endothelial cells, a smaller area, as seen in silver-preparations, is produced between the areas of the endothelial cells. These spaces we will call pseudo-stomata.

The lymphatic system may be injected both in normal and in pathological conditions; even more easily in the latter provided the alterations have not gone beyond a certain point. The first method we used was that of Ludwig and Schweigger-Seidel, maintaining artificial respiration. Another method, that of Recklinghausen, consisted in injecting various substances into the abdominal cavity; such as starch emulsion, starch and oil, a solution of alkanin in turpentine, which was divided into minute drops by shaking it up with concentrated gum solution; anilin and oil, a mixture in which the oil drops become readily and fully coloured with the pigment; anilin and milk, blood, and a five per cent. solution of Brücke's Prussian blue.

The most successful and perfect injection was obtained by keeping a rabbit sixteen or twenty hours without food, and then injecting ten cubic centimètres of the mixture of milk and aniline, or, still better, of the five per cent. Prussian blue solution into the abdominal cavity. After three or four hours the animal was killed by bleeding from the crural artery or was strangled. The whole lymphatic vascular system of the diaphragm then appeared in every case completely injected, as did also the ductus thoracicus, the sternal vessels and the sternal glands. The bronchial glands, on the other hand, were only occasionally and imperfectly injected.

Injection seldom succeeds so well with the healthy guinea pig as with the rabbit. The most perfect injection of the centrum tendineum in the latter was obtained in animals affected with artificial tuberculosis (or secondary inflammation, Sanderson), which had died in consequence of

rupture of the spleen, producing copious hæmorrhage into the abdominal cavity. The lymphatics of the diaphragm were then perfectly injected with blood.

We have also succeeded, as did Recklinghausen, in injecting the plasmatic canal system. In animals affected with somewhat advanced peritonitis, which had had aniline and milk, Prussian blue, or aniline and oil injected into their abdomen, the plasmatic canals were found more or less filled with the substances injected, and these sometimes appeared as if simply deposited upon the plasmatic canal-cells, at other times had plainly made their way into the substance of these cells. Whenever the centrum tendineum was affected in such a way that the lymphatics of the fissures were blocked up, as, for instance, by the products of inflammation or by starch and oil some time after its introduction, the plasmatic canal system on the abdominal side, and the tendinous tissue were found very considerably injected.

It is plain both from this fact and from the anatomical details above mentioned, that absorption may take place not only through the true stomata into the lymphatic vessels, but also in a second way through pseudo-stomata and plasmatic canals into the lymphatic vessels. We shall return to this point in speaking of the pathological conditions.

(*b*) *Pathological alterations.*—In acute peritonitis, whether produced by wounds of the intestine and escape of fæcal matter, or by injection of irritating substances (iodine, ammonia, &c.) into the peritoneal cavity, the endothelium ot the peritoneal surfaces shows alterations of the same kind as described by Kundrat and Ranvier in speaking of the morbid alterations of the endothelium. It is not difficult to discover, bearing in mind the normal conditions of the centrum tendineum, that this is only the case in certain regions, which are as follows :—the endothelium covering the lymphatics of the fissures; that covering the network of lymph-capillaries which surround the large vessels passing through the diaphragm; and that covering the sinuses connected with the lymph-capillaries which unite vessels of the fissures.

We have frequently observed that after the inflammation has lasted a certain time, the endothelial cells over these spots put forth buds which separate as young amœboid cells. Complete information respecting these changes may be gained from the study of chronic inflammations, such as are produced by inserting pieces of gutta percha in the abdominal cavity, by the presence of psorospermia in rabbits, by introducing starch and oil, &c., or in artificial tuberculosis. The morbid alterations are seen first and most distinctly in the

neighbourhood of the stomata and pseudo-stomata. Near the true stomata are seen swellings and buds formed by the proliferating endothelial cells, which project above the surface and form in their first stage of development a sort of wall round the stoma, so that the channel connected with the opening looks as if lengthened, or, when further developed, forms a hollow cone.

In some cases of chronic inflammation similar changes are found on the pleural side to those already described on the abdominal side, the endothelium here also showing proliferation round the pseudo-stomata. The system of plasmatic canal-cells is also found to be altered in the same manner as lately described by Hansen in the case of the cells of the cornea, a process of which some indication may be found, as stated above, even under normal conditions in certain parts. The cells first appear to enlarge, their protoplasm becomes distinctly granular, the nucleus becomes clearly defined and is marked with depressions. In the next place, the processes also begin to grow, and the body of the cell with its processes splits up into single cellular laminæ. We then have rows of cells arranged more like endothelium, in which the individual cells are separated from one another by narrow lines of cement. Another change, however, soon takes place, which can hardly be paralleled in normal conditions, namely, that buds begin to grow from particular points of the body or processes of the cell which then separate themselves as young cells.

In some chronic inflammations, such as artificial tuberculosis, the plasmatic canal-cells may be seen to form nodes and plates by proliferation; this occurs at places where there is at the same time superficial inflammation.

The question arises where these young cells, which are met with in limited number under normal conditions, but under pathological conditions in considerable numbers, both in lymphatic vessels and in the plasmatic canals, originate. It is certain that a large proportion of them may be regarded as derived from the proliferating endothelial cells in the neighbourhood of the true stomata and pseudo-stomata, as well as from the plasmatic canal-cells, while some are sucked in from the abdominal cavity.

These conditions will be referred to again in speaking of the omentum, where they can be investigated with greater precision.

II. *Omentum and Mediastinal Pleura.*

a. Normal conditions.

The omentum and the mediastinal pleura are constructed in a perfectly similar manner.

The omentum has lymphatic vessels, which in the neighbourhood of the greater curvature of the stomach form an abundant network. In the rest of the omentum, a few single lymphatic trunks are found corresponding to the large blood vascular trunks, and these are connected together by lateral vessels. In the rabbit the lymphatic vessels in general are abundant. In the guinea-pig, cat, dog, and monkey, larger or smaller spots are found in the normal condition where the endothelial cells are not pale plates, but have a youthful appearance; the individual cells are cubical, and consist of a granular protoplasma enclosing a single, oblong, partly divided or double nucleus.

The trabeculæ of the fenestrated portion are in this respect especially instructive; spots may here be found where a proliferation of the endothelium is clearly demonstrable, that is to say, there may be seen budlike masses of various size, consisting of young endothelial cells. The same appearances are presented on and near the cords in the fatty lobules, which contain the larger blood-vessels, and in nodular structures more or less raised above the surface, which are partly connected with the large vascular cords, and partly occur isolated in the fenestrated portions. The mesogastrium of the frog exhibits the same phenomena, only that here the young endothelial cells are ciliated.[1]

The endothelial cells have this character in every part where true stomata or pseudo-stomata are to be found. This is the case in the fenestrated omentum only near the pseudo-stomata, in other parts both near the true and the pseudo-stomata. In the rabbit the endothelium shows the same character in certain more or less clearly defined, flat, tablet-shaped structures, and in the cords containing the blood- and lymph-vessels.

The cellular structures of the connective-tissue of the omentum may be, generally speaking, like those of the centrum tendineum, separated into two layers. The one situated under the endothelium consists of large flat branched cells which in some parts lie closer together, and possess shorter and fewer processes, and are even occasionally so closely set as to be separated only by their cement lines. In the latter case we find under the endothelium of the surface a more or less clearly defined spot where treatment with silver produces the same appearance as in the lymph-capillaries of the centrum tendineum. It is, in fact, nothing but a lacuna, which as we

[1] See a notice by E. Klein in the last number of this Journal.

learn from many circumstances, arises from the fusion of several subendothelial plasmatic canals, and is covered on one side only with an endothelium. These simple isolated lacunæ communicate with the neighbouring plasmatic canals, or, in other words, the endothelial cells which border the gap are continuous with the surrounding plasmatic canal-cells.

The endothelium of the surface covering the lacunæ is in general flat, only here and there cubical cells with two or three nuclei may be seen arranged round a hole. This hole is an actual breach of continuity in the endothelium leading into the lacuna. It is accordingly a third form of stoma, which also we will call a true stoma.

The subendothelial plasmatic canal-cells are in connection with those of the fascia proper. The latter are also in general flat and more or less branched. At particular spots they are united into groups, and as such form the chief constituents of the nodes, plates, and vascular cords above spoken of, and an enlargement of these structures by multiplication of the plasmatic canal-cells similar to that which takes place in the centrum tendineum may be traced here. In most of them a system of true blood-capillaries may be recognised, which extends itself in proportion as the above-mentioned structures multiply and increase. These vessels are closely connected with the plasmatic cells, being completely surrounded by them as by a sheath, and single processes of the cells being directly attached to the capillary wall. The cells are also themselves, as in the centrum tendineum, directly continuous with the endothelial cells of the adjacent lymph-capillaries or lymph-sinuses.

The formation of new capillary blood-vessels was quite distinctly made out in numerous places to be as follows: In one of the plasmatic canal-cells which is in connection with the endothelium of the capillary vessels, there arises a cavity or vacuole which extends into a process and opens into the cavity of the capillary tube, while the protoplasmic envelope splits up into separate cellular plates.

Numerous young cells are seen within the plasmatic canals of all these newly formed structures, and are derived from the superficial endothelium.

Although it is clear from the pathological phenomena and the result of the injections that both the young cells and the foreign bodies introduced into the plasmatic canals are situated *upon* their cells, still it is highly probable that a circulation of these substances also takes place *within* the protoplasma of the cells.

The adipose tissue which occurs in the omentum in the

form of cords and lobules resembles the structures above described, in its anatomical structure, so far as regards its superficial endothelium, plasmatic canals, blood- and lymph-vessels. We perfectly agree with the statements of Flemming in regard to the development and significance of adipose tissue, and will here only repeat that fat-cells are branched cells (plasmatic canal-cells) containing one or more oil drops.

Before speaking of the pathological aspects of these tissues we wish to describe a structure which throws much light on the evolution of adipose tissue.

Near the *glandula infraorbitalis* of young rabbits is found a gelatinous body, which is separated from the eye and its surrounding fat by a thin membrane, rests upon a large venous plexus, and is immediately behind the maxillary bone. It has a smooth polished appearance precisely like that of a serous membrane.

If the skin and fascia are divided in the living animal, and a small piece of this gelatinous body removed and examined in fresh serum, it shows in addition to sinuous bundles of connective tissue, a large number of cellular structures. There are beside amœboid cells, spindle-shaped structures of various size. Some are pale and have a pale oblong nucleus, others extremely long, coarsely granular, with a swelling in the centre or sometimes near one of the tapering ends. These tapering ends may be clearly seen with a very high power (No. 10 immersion of Hartnack), to run out into a simple or divided bundle of the finest fibrillæ, which may be traced, gradually diminishing in size, to the similar process of an adjacent cell. Another preparation shows, on the contrary, an entirely different appearance. Here only dim outlines of flat structures can be traced in the hyaline substance. After a short time, sometimes immediately the cover glass is put on, these plates are seen to have a distinctly fibrillar structure. A more or less distinct nucleus is seen in the centre surrounded by a narrow belt of finely granular substance, and outside of this are the closely set fibrillæ which run in curved lines through the plate and pass into, that is, form the processes. Granules occur between the fibrils. These plates vary much in size as well as in the width of their processes. Now a simple manipulation shows that the spindle-cells above mentioned (which are precisely similar to those which have been often described from embryonic connective tissue), are only the structures of the second preparation seen in profile. It is only necessary to take a preparation contained in a somewhat large quantity of serum and move

the cover glass to and fro over it with a needle; when this is done, these "spindle-cells," whose long axis is parallel to the side of the cover glass at which disturbance was applied, turn round, show their flat sides and are then seen to be plates, when the glass returns to its former position. They again show their edges, appearing spindle-shaped and granular. Preparations from the same part also show very beautifully the development of fat, &c.

b. Pathological conditions of the Omentum.

In chronic inflammations the following alterations generally take place. The endothelium of the surface is in a state of active proliferation, and especially at those spots where we already observed proliferation in the normal state, that is, at the stomata. The endothelium multiplies here as it does in the centrum tendineum, so as to form buds and cones raised above the surface.

The plasmatic canal-cells undergo alterations of the same kind as were described in the case of the centrum tendineum. One phenomenon seen in certain parts of the parietal peritoneum in young rabbits and guinea-pigs must be mentioned. The plasmatic cells which were swollen and also sometimes showed division of the nucleus, showed also in their interior larger or smaller molecules of fat and sometimes a vacuole. This vacuole again contained, though it was not completely filled by, a fat-globule, together with several young cells. The envelope of protoplasm surrounding the vacuole was thin, granular, nucleated, and connected by processes with the neighbouring cells. Some of the young cells contained therein were, doubtless, derived by division from the protoplasmic envelope, but others were, in all probability, migratory cells which had found their way in.

In a certain stage of chronic inflammation produced by the methods already enumerated, systems of nodes, cords, and bridges, are found stretched over the surface of the omentum and detached from it.

These structures are wholly or in part covered with young endothelium, and when they have reached a certain size are provided with vessels, lymphatic sinuses, and a variable number of migratory cells.

The development of the above structures exhibits the following stages:—

(*a*) First of all, at places where there is a pseudo-stoma the plasmatic cell constituting the pseudo-stoma puts out an abruptly projecting homogeneous process; the endothelium

surrounding it proliferates, and after a time the process, gradually becoming longer and thicker, is enveloped by a covering of young endothelial cells. In a further stage the process itself divides into several distinct cells, and we have a cone or knob, the centre of which is formed of young cells, clearly distinguished from the covering of young endothelia.

(*b*) In the second place, the endothelium which borders a stoma, itself grows luxuriantly and projects freely from the surface. Two or three endothelial cells may be seen to elevate themselves on a pedicle from the serous surface, and become drawn out lengthways. Other cells doing the same, a long thin cord is produced which depends from the surface. In a further stage a distinct homogeneous axial cord may be seen enveloped by the endothelial cells; this axis tapers away towards the point from which the proliferation of endothelium commenced and stops short near this point. Later on this axis appears as a bundle of minute connective-tissue fibrillæ which may be with great probability supposed to arise from division, or, to use Rollett's expression, by a sort of "coining" of the homogeneous mass.

(*c*) The endothelium of the true stomata grows out in cones, in such a manner that a cavity remains in the middle which is a prolongation of the lymph-sinus to which the stoma belonged.

(*d*) A considerable number of the nodes projecting from the surface owe their existence only to an excessive growth of the nodes which occur in the normal omentum, on or near the vascular sheaths or fatty lobules, or else in the fenestrated portion.

The cords described under the head (*a*) often grow into extremely long trabecular structures, the cells which form their solid axis multiplying, becoming branched and separating from one another. Two such cords may unite and form a new node at their point of union, which node is then connected by two bridges with other parts of the omentum.

The formation of vacuolæ in the plasmatic canal-cells in the chronic inflammatory process plays an important part. Although the cells in which the vacuoles are formed appear to be round cells without processes, it still appears probable that they originate in flat branched plasmatic canal-cells, buds from which being set free have become young cells. A vacuole arises in a plasmatic cell and is prolonged into a process, while its wall divides into cellular plates; then by opening into a blood-capillary it may form a new blood-vessel, by opening into a lymph sinus a new lymphatic vessel. Ciliated lymph

sinuses may be also thus formed as shown by one of the authors in this Journal (Q. J. M. S., Jan., 1872.)

The same process of vacuolation may occur and play the same part in the cells of the new structures (buds, &c.) above described. Finally, by opening on the surface the vacuolated cells may form true stomata.

On the occurrence of parasites and fungi within the vacuolated cells and the lymphatic sinuses, we have not sufficient experience to come to any decided conclusion.

We have little to add to what is already known of the lymphatic system of the costal pleura and mesentery. In their normal anatomical characters and the phenomena of chronic inflammation, they agree generally with what has been stated about the centrum tendineum. The details of the methods by which the above results were arrived at, precise literary references and confirmations of the chief facts alleged, will be given elsewhere.

REVIEW.

THE LENS: *A Quarterly Journal of Microscopy and the Allied Natural Sciences; with the Transactions of the State Microscopical Society of Illinois.* Chicago, 1872.

THIS, though the first number of a new journal, has a retrospective as well as a prospective interest, for it is a relic of the great fire of Chicago—that terrible calamity, besides doing more serious damage, having been the occasion of the publication of this journal being deferred from October, 1871, to January in this year. The history of the journal must, however, first be told; it is partly that of the State Microscopical Society of Illinois. This society was founded in December, 1868, under the title of the Chicago Microscopical Club, and incorporated by state charter in 1869, under the name which it now bears. The society then held regular meetings till last year.

"The first autumn meeting of the society should have been held on October 13th, 1871, and preparations had been made by which the opening meeting of the season would have been most interesting and valuable. The great conflagration of October 8th and 9th, however, temporarily interfered with the society's plans. Of the fine building of the Academy of Sciences, with its highly interesting and valuable contents, nothing remained, when the appointed time of meeting arrived, but a pile of smoking ruins.

"The secretary and treasurer, at their great personal peril, succeeded in preserving the records and securities of the society; but the cabinet of objects, and the small but valuable library, except such portions of each as were loaned to members residing outside the burned district, were destroyed. The entire edition of the first number of 'The Lens,' also, was just completed, and was burned, save half-a-dozen copies, which the editor, by good fortune, happened to have at his home.

"As soon as it was possible to ascertain the exact status of the society, and the opinions of its members, a meeting

of the Board of Trustees was held, at which it was determined to reissue the first number of 'The Lens,' with such changes as might appear warranted, and to resume immediately the scientific meetings of the society.

"In accordance with this action, the first scientific meeting was held on December 8, 1871."

The number before us contains several original articles, one or two reprints, together with the reports of the proceedings of the State Microscopical Society and the Academy of Sciences, and a few pages of notes and miscellanies.

The first article, by Professor H. L. Smith, contains an elaborate "Conspectus of the Families and Genera of the Diatomaceæ," which we cannot, of course, pretend to criticise now, but which bears traces of great labour, since it includes "as admissible, or among the synonyms, the name of every genus hitherto constituted." Mr. Babcock gives a list of the phænogamous plants found within forty miles of Chicago.

The next paper is entitled, "On the Preparation and Preservation of Sections of Soft Tissues;" and is by Dr. Danforth. Its object is to recommend plain, inexpensive, and simple methods of research to the notice of medical practitioners. We must confess, with every desire to see research simplified, that some of Dr. Danforth's methods strike us as rough and ready rather than precise or trustworthy. One contrivance of his for collecting and bringing specimens home appears, however, ingenious and useful. He calls it a compound glass cell, and it consists of a thick slab of plate glass, in which six deep cells are excavated. The cover consists of another plate of glass, of the same size, and the two are fastened together by a strong india-rubber band. Specimens of pus, of expectoration, of mucus, or of solid tissues, may be easily carried without being soiled or injured.

Another article on the same subject, the first of a series, intended for medical practitioners, is signed with the well-known name of Dr. J. J. Woodward, of the United States army. It describes the methods of preparation used in the microscopical section of the Army Medical Museum, and, though we need hardly say that it is thoroughly up to the mark, there is nothing in the present number which would be any great novelty to our readers. A long list of the Diatomaceæ of Lake Michigan is given by Mr. Briggs, and there are other articles, on "A New Fossil Echinus," on "A New Method of illuminating Opaque Objects under High Powers," by Dr. Johnson; and a reprint of "A Monad's Place in

Nature," by Mr. Metcalf Johnson. Dr. Johnson's method of illumination is very simple and ingenious, and appears to be new. A beam of light is sent down the oblique body of the binocular microscope by a plane mirror, a rectangular prism, or the ordinary drawing camera. It falls upon the Wenham prism, and is by this directed through the objective upon the slide, the prism being of course arranged as for binocular vision. A small portion of the centre of the field will then, if all the adjustments are correct, be brilliantly illuminated.

Having thus given, so far as possible, a notion of the actual contents of the first number of 'The Lens,' we might almost escape the necessity of pronouncing any formal judgment; for it is obvious that the subjects constitute a very rich and varied field of activity, and that the execution has merits of a very high order. If the promise of the first number is borne out by those which follow, we feel confident that 'The Lens' will take a high and independent position among scientific periodicals. In the name of the oldest of existing journals devoted to microscopical science, we cordially welcome this, her youngest sister, who so narrowly escaped perishing among the ruins of Chicago.

NOTES AND MEMORANDA.

Journal of Cryptogamic Botany.—Mr. M. C. Cooke, the well-known mycologist, announces his intention, if the names of a sufficient number of subscribers can be obtained, to issue monthly a small journal, with illustrations, devoted absolutely to Cryptogamic Botany. It will serve as a sort of Appendix to the Lichen and Fungi Floras recently published, by recording and describing new species as they are found. Although British Cryptogamia will occupy the first place, it is intended to record from time to time what is doing abroad in all the Cryptogamic families (except ferns), and to keep the student acquainted with what is being published in foreign countries as well as his own. Monographs of genera and families, critical observations on species, and all kindred subjects, will receive attention. The co-operation is promised of the Rev. W. A. Leighton, Dr. Lauder Lindsay, Dr. Braithwaite, F. Kitton, and other specialists.

Hop Mould.—A new mould has made its appearance during the past autumn on the spent hops so common about Burton-on-Trent. It formed large dense patches of a bright salmon colour, sometimes several inches in length and breath, upon the sombre hops, and could not have escaped notice had it appeared in previous years. The structure of this mould seems to be closely allied to that of *Oidium*, whilst in many respects it reminds one of *Sporendonema casei*. The creeping mycelium gives rise to branched threads, which become divided into strings of oval conidia or spores. The mould refuses to develop itself artificially, so that the mode in which the beaded spores were produced was not absolutely determined. Directly the threads come in contact with fluid of any kind they are resolved into a mass of oval cells or spores. Specimens of this mould have been published and distributed in Cooke's 'Fifth Century of British Fungi' under the name of *Oidium aurantium*, a rather unfortunate specific name, since another member of the same genus which appeared nearly simultaneously on the Continent has been called *Oidium aurantiacum*.—(M. C. C., in *Nature*.)

Development of Crustacea.—At a recent meeting of the Geological Society a paper was read, entitled "Further Remarks on the Relationship of the *Limulidæ* (*Xiphosura*) to the *Eurypteridæ* and to the *Trilobita*." By Mr. Henry Woodward, F.G.S. In this paper the author described the recent investigations made by Dr. A. S. Packard, Dr. Anton Dohrn, and the Rev. Samuel Lockwood upon the developmental history of the North American Kingcrab (*Limulus Polyphemus*), and discussed the conclusions as to the alliances of the *Xiphosura* and *Eurypteridæ*, and to the general classification of the *Arthropoda*, to which the results of these investigations have led Dr. Dohrn and some other Continental naturalists. According to this view, the *Xiphosura* and *Eurypteridæ* are more nearly related to certain Arachnida (the Scorpions, &c.) than to the Crustacea; and this opinion is further supported by the assertion of Dr. Dohrn, that in *Limulus* only one pair of organs (antennules) receives its nerves from the supraœsophageal ganglion, and that the nature of the underlip in *Limulus* differs from that prevailing among the Crustacea. Dr. Dohrn also recognises the relationship of the Merostomata to the Trilobites, as shown especially by the development of *Limulus*, and considers that the three forms (*Limulidæ*, *Eurypteridæ*, and *Trilobita*) should be combined in one group under the name of *Gigantostraca*, proposed by Haeckel, and placed besides the Crustacea. The author stated, on the authority of Professor Owen, that *Limulus* really possesses two pairs of appendages which receive their nerves from the supraœsophageal ganglion; that, according to Dr. Packard, the young *Limulus* passes through a Nauplius stage while in the egg; that no argument could be founded upon the lower lip, the condition of which varied extremely in the three groups proposed to be removed from the Crustacea; and he maintained that even from the ultra-Darwinian point of view taken by Dr. Dohrn, the adoption of his proposal would be fatal to the application of the hypothesis of evolution to the class Crustacea. Professor T. Rupert Jones, Professor Macdonald, and others, having made some remarks, Mr. Woodward, in replying, drew attention to the diagrams of the embryo and larva of the recent *Limulus*, comparing them with *Limulus* of the Coal-measures, *Neolimulus* of the Silurian, and also with the larval stages of the Trilobites, discovered by Barrande. He pointed out the strong resemblance which the fossil forms offer to the early stages of the modern King-crab, and expressed his assent to the proposal of Dr. Dohrn to bring the Trilobita, if possible, nearer to the

Merostomata. If, however, the Trilobites have true walking-legs instead of mouth-feet (gnathopodites) only, they would be more closely related to the Isopoda. He showed by a tabular view of the Arthropoda that the known range in time of the great classes is nearly the same, and therefore affords no argument for combining the Merostomata with the Arachnida; but on the contrary, he considered that the Trilobita were, with the Entomostraca, the earliest representatives of the class Crustacea, and could not therefore be removed from that class.—(*Nature.*)

The Asci in Peziza.—Having left a specimen of *Peziza humosa* for a long time in water, until it became quite soft and pulpy, I was curious to examine it in such condition, and found that the hymenium presented a singular appearance. All the paraphyses had become dissolved into a granular mass, retaining still some of their original colour. Amongst these the asci were free, and there were some free sporidia. In their normal condition the asci are cylindrical, and the sporidia are arranged in a single series; but in the present case the asci had become perfectly spherical, from the absence of all lateral pressure, and the sporidia were clustered in the centre. The line of the external surface of the asci was very distinct amongst the orange-tinted granular mass, and the eight sporidia could be counted within. There could be no doubt of the presence of an investing membrane, but of a much more elastic nature than has been supposed. This fact seems to suggest the probability that more or less lateral compression in the hymenium may influence the character of the asci, and that cylindrical, or clavate and elliptical asci, indicate more or less lateral pressure during development.—(M. C. C., in *Nature.*)

Carmine Tinting of Objects hardened in Chromic Acid.—It is well known that tissues which have been long hardened in chromic acid are coloured by carmine solution with great difficulty, and sometimes very imperfectly. The following method, given in the preface to the last part of Henle's 'Anatomy,' has been invented by Merkel to obviate this difficulty, in the case of preparations of the nerve-centres. By means of it an object may be perfectly tinted in five minutes, which would by the ordinary method require twenty-four hours. The section, when thoroughly deprived of water, is placed in a solution of chloride of palladium in 300 or 600 parts of water. In this it is allowed to remain long enough to acquire a pale yellow or straw colour, which takes one or two minutes. The excess of palladium solution is then washed out, and the section placed in a somewhat con-

centrated ammoniacal solution of carmine. In this it becomes almost instantaneously coloured red, and the most beautiful colour is obtained when the red still shows a slight shade of yellow. The section is then washed and prepared in the usual way for putting up in Canada balsam or Dammar varnish. The axis cylinder is, in preparations made by this method, bright red, and the medullary nervous matter yellow; if allowed to remain too long in the carmine solution, the medullary substance also becomes red, which, however, does not interfere with the distinctness of the preparation. If the sections remain too long in the palladium solution, they gradually become darker, and are spoilt.

Molybdate of Ammonium.—This reagent is also recommended by Merkel in Henle's 'Anatomy,' for tinting preparations of the nervous system. The solution is thus prepared:—One part by measure of a quite concentrated solution of molybdate of ammonium is diluted with one or two parts of water; to this solution is added as much iron filings as will lie upon the point of a knife, and commercial hydrochloric acid is slowly added, drop by drop, with continual agitation, till a deep blue, almost black, colour is produced. The white flocculent precipitate first formed on addition of acid is of no consequence, and readily redissolves on agitation. If, however, the solution becomes brown instead of blue, as sometimes happens, it is useless. When the solution has acquired the desired colour, it is allowed to stand for ten minutes, and then filtered. A blue solution is thus obtained, which may be, if necessary, diluted with water. Sections of the spinal cord, or medulla oblongata (it is less suitable for brain), laid in it are stained blue, according to the degree of concentration of the solution, in six to fifteen hours. The coloration is very thorough, and apparently homogeneous, though in good preparations the axis cylinder shows very clearly. The preparations may be put up in the usual way in Canada balsam, being first dehydrated by alcohol, and rendered transparent by oil of cloves.

Œsophagus of Sauropsida.—At a late meeting of the Zoological Society a paper was read on the œsophagus of the hornbill, a bird which, though known to eject food or other matters voluntarily by this tube, now proves to be devoid of an œsophageal sheath of transversely striped muscle; and this fact agrees with the former observations of the author, Mr. Gulliver, that such sheath is wanting in reptiles and birds, while fishes and mammals are regularly provided therewith. In this highest class, the difference of the extent of the striped muscle on the œsophagus of different orders is

so constant and remarkable as to afford excellent diagnostic characters, as the author had shown upwards of a quarter of a century since, in the 'Proceedings of the Zoological Society,' June 14, 1842; and he regards the whole facts revealed by this purely microscopic inquiry as of much taxonomic value.

On the Preservation of Compound Ascidians.—Mr. C. W. Peach, in a paper read before the Royal Physical Society of Edinburgh, stated that, when living at Cornwall, he was much struck by the beauty of the compound ascidians so abundant on rocks, &c., between tide-marks there, and that he was perfectly aware that the beauty of the colours and flower-like systems of these lovely objects was always lost, whether they were preserved in spirits or any other fluid. He thought of Canada balsam—the great difficulty of contending with wet objects suggested itself. He, however, tried, and so far succeeded, by laying them on glass (when detached from the rocks), after squeezing out as much as possible of the moisture by first laying them in cotton or linen rag between sheets of blotting-paper, changing these as often as required, and doing all as quickly as possible, after taking the object from the sea. Thus dried, they were placed on glass covered with warmed Canada balsam, and covered with another similarly prepared plate of glass, on which sufficient balsam was melted to cover up completely the specimen. It is then allowed to cool under slight pressure, the superfluous balsam scraped off, and sealing-wax put round the edges to form a cell, and thus they were preserved. He exhibited several specimens—some preserved twenty-five years ago—of Leptoclinum, Botryllus, Didemnum, Paracidra, &c., in a beautifully preserved condition.

On the Presence of Fungi in the Blood of Healthy Human Beings.—Dr. Lostorfer, of Vienna, has made some interesting researches on the development of a fungus resembling Sarcina ventriculi in the blood of healthy individuals after removal from the body. His method consists in procuring a drop of blood from a carefully cleaned finger, placing it, with careful precautions as to cleanliness, on a glass slip under a cover glass, and preserving for several days the preparation thus made in a moist atmosphere under a bell-glass. Specimens obtained in this way from eleven persons were carefully examined, day by day, with a Hartnack's No. 10 object-glass (about equivalent to an English $\frac{1}{18}$). On the first two days nothing very definite was seen; but on the third day, almost without exception, were seen groups of pale granules, sometimes consisting of two or four only, sometimes of twelve or more. These granules were larger than the granules of

leucocytes, were sometimes closely pressed together, at other times loosely attached to one another, but without any regularity of arrangement. On the fourth day, however, there was not only an increase in the size and number of the granules, but they were distinctly arranged in groups of four, after the manner of Sarcina, and showed also the characteristic angular or quadrate form produced by mutual pressure. After this no change occurred, except multiplication of the elements, and a slight further increase in their size, which only lasted over the fifth day. In about ten days the preparations were spoilt. The only exception to the regularity of this process was observed when the preparations were kept in too cold a place. In this case the granules continued to multiply very rapidly, but diminished in size, and showed no kind of symmetrical arrangement: removal to a warmer situation produced a rapid development of normal sarcina forms. The Sarcinæ thus obtained differed from the well-known Sarcina in being smaller and united into far more numerous groups; also they were always quite colourless. The size, however, and the colour approached those of the normal fungus, when Pasteur's fluid was added to the blood, in which the blood Sarcinæ were developing. No appearances were ever seen tending to show that Sarcinæ existed in the circulating or freshly drawn blood; and, by a series of controlling experiments, it was shown that albuminous solutions, Pasteur's fluid, and other similar media, did not develop Sarcinæ under the same conditions as those under which they appeared in blood. Lostorfer further explains, by the supposition of Sarcina germs always existing in the blood, the occurrence of the "fungus" itself in unusual situations in the human body, such as the lungs, urine, &c., which has been explained by supposing that it was conveyed from the stomach.—(*Stricker's Medizinische Jahrbücher*, 1872.)

The constant occurrence of Sarcina Ventriculi (Goodsir) in the Blood of Man and the Lower Animals.—Dr. Ferrier writes on this subject,—The results of numerous experiments which I have been making for a different purpose appear to me to warrant the conclusion that organisms which develope into such as have all the characters of sarcina ventriculi are a constant, if we cannot call them a normal, occurrence, in the blood of man and the lower animals; and that the name *sarcina sanguinis* would indicate more truly the natural seat of the organisms. In reference to human blood, I find I have been anticipated by Lostorfer ('Wien. Med. Jahrb.,' 1872), who by a different method has succeeded in developing organisms like the sarcina ventriculi from the blood of several

healthy individuals. That his observations are correct, my own experiments, both in reference to human blood and the blood of various lower animals, will fully show. In the case of rabbits, cats, dogs, and frogs, the special subjects of physiological experiment, I took sufficient precautions to ensure against introduction of organisms from without, by allowing the blood to run directly from the carotid or other large vessel into tubes (previously raised to a white heat), which were then immediately sealed; or into flasks similarly prepared and stopped with cotton-wool. Human blood was introduced into similar tubes from a slight incision in the arm or hand, previously carefully cleaned. The blood was then placed under a temperature of 100° F.; and in every instance, at the end of a week or ten days, and in some cases examined first at the end of two months, immense numbers of beautifully formed sarcinæ were found. In the frog's blood, as well as in human blood and the others, the sarcinæ, as to size and otherwise, presented exactly the characters of sarcina ventriculi. Blood taken from the arm of a patient at the height of enteric fever gave the same results. No other organisms were observed. In all these specimens there was entire absence of putrefactive changes. This would of itself sufficiently establish the fact of freedom from external contamination.

Though the same precautions against contamination could not be taken with the blood of the sheep and ox, sarcinæ were developed in a similar manner. With the occurrence of putrefaction, however, they appeared to become disintegrated, or at least were less easily recognised. I have never observed fully formed sarcinæ in the circulating blood, but have constantly found numerous refractive granules, single or in pairs. From these, as have been observed also by Lostorfer, the sarcinæ are developed. Their previously doubtful nature is thus satisfactorily explained.

Though a special examination and cultivation of the blood of every animal would be necessary in order to say with perfect certainty that they exist in every case, sufficient grounds have been shown that they only require to be looked for.

True sarcinæ have never been found otherwise than in the bodies of animals or their excreta. The real source of sarcinæ, therefore, in the various circumstances in which they occur, is naturally to be looked for in the blood itself. That they do not occur in mere transudate liquids, the entire absence of them in hydrocele fluid cultivated in a similar manner would seem to show. It is probable, therefore, that their

evolution is due to direct egress of the germs from the vessels with the blood itself. This explanation is quite in accordance with the facts of the cases related, in so far as they have been fully recorded. In the stomach, they are usually found with perforating ulcer or other diseased condition of that viscus. Their occurrence in the urine has always been associated with disease of the kidneys or the bladder. In the cerebral fluid, in Jenner's case, they occurred along with blood-corpuscles. Their occurrence in gangrenous cavities can easily be explained in a like manner.

In all cases there have been favorable conditions in hollow viscera or cavities for the development of the sarcinous germs, directly carried to their surface by effused blood.

The blood in which the sarcinæ had developed to an enormous extent always retained its alkalinity. There was no sign of putrefaction or fermentation, and no gaseous evolution. Sarcinæ directly introduced into a tube containing boiled Pasteur's fluid standing over mercury, and under conditions favorable to fermentation, caused no such phenomenon.

The above facts will serve to throw light on the nature of sarcinous vomiting. Sarcinæ neither generate acids in organic fluids, nor is their growth accompanied by the evolution of gases. Constantly, however, in the characteristic sarcinous vomit, there are, along with sarcinæ, immense numbers of torulæ and bacteria. So constant is this association, that some have attempted to establish a developmental relation between sarcina and torula. This my own experiments entirely negative. Bacteria and fungi are the great, and, I may say, the only, cause of putrefaction and fermentation.

The constant presence of sarcinæ is a point of great importance in reference to the whole question of contagion and the nature of disease-germs. It throws especial light on a much-discussed subject—viz., the nature of the vaccine particles which are constantly to be seen in fresh lymph. In numerous experiments made by Dr. Burdon Sanderson and myself in reference to vaccine, we found, on cultivation of fresh lymph in suitable organic fluids, that the particles multiplied, and assumed, in many instances, a form resembling sarcina. I have now not the slightest doubt of the nature of these particles, and regard them as the ordinary *sarcina sanguinis*. The conditions of vaccination are just such as would readily account for the presence of these organisms in the developed vesicle. It is more than probable that sarcinæ,

if looked for, will be found in most pathological fluids. The subject only requires further experimentation.

Sarcinæ still remain as mysterious as ever. What is their true nature? Are they parasites, or are they a normal constituent of the blood? are questions on which one might speculate, but which I reserve rather for experimental solution.—*British Medical Journal.*

Heterogenesis.—Dr. Bastian has been contributing a series of articles on this subject to the 'British Medical Journal,' in which he aims at proving what he had elsewhere ('Modes of Origin of Lowest Organisms,' 1871) endeavoured to show, by cogent experimental evidence, that when organic matter undergoes decay or putrefaction, a double process of composition and decomposition invariably occurs; *i. e.*, the complex organic substances break up into simpler binary compounds, during which the previously locked up forces are instrumental in bringing about new synthetic changes among other constituents of the organic matter. The new products thus evolved appear as specks of living matter, which gradually grow into *Bacteria*, *Torulæ*, or other simplest forms of life.

His first two articles are chiefly occupied with recounting the observations and theories of various French naturalists, as M. Turpin, who held that milk-globules are transformed into germs which produce a species of Penicillium; M. Trecul, who traced the conversion of organic matter in vegetable cells and vessels into living organisms, &c. The following are some of Dr. Bastian's own observations:

"During the examination of some specimens of sugar-cane in a sickly condition which were brought under the notice of the Scientific Committee of the Royal Horticultural Society about three years ago, I first became convinced, from personal observation, that *Bacteria* and larger fungus-germs may be encountered within the closed cells of living plants. I found, on making thin sections of the central tissue even of young shoots, that many of the cells contained an abundance of *Bacteria*, and others a smaller number of *Torula*-like corpuscles, whilst some of the surrounding cells were quite free from either. I have since found the same kind of thing when examining the central portions of decaying tubers, and other fleshy parts of plants. Actual mycelial growths are, moreover, to be found in various situations, to which we might pretty confidently suppose that no external germs could ever have penetrated. They have been found, for instance, in the liquid juice taken from freshly broken cocoanuts, from the interior of walnuts and filberts, and from the

central portions of stone-fruits, such as plums and peaches, whilst the surrounding and external fleshy portions are quite uninjured and unaffected. Speaking of *Botrytis infestans*, which he regards as 'the proximate cause of the potato murrain,' the Rev. M. J. Berkeley says ('Introd. to Cryptogamic Botany,' 1857, p. 65): 'The walls of the cavities of the carpels of tomatoes are often covered with fungus, though there is no communication with the outward air; and a crop of the mould has been seen to grow in a few hours from the cut surface of a diseased potato even though the foliage itself had exhibited no trace of the parasite.' Multitudes of such facts might be referred to, but the facts themselves are, I believe, admitted by all. Dr. Lionel Beale, for instance, says, 'Lowly vegetable germs appear in closed cavities in the substance of dead animal and vegetable tissues. I have often seen them within vegetable cells in which not a pore could be discovered when the tissue was examined by the highest powers.' And again he says, 'I have detected them in the interior of the cells of animals, and in the very centre of cells with walls so thick and strong that it seems almost impossible that such soft bodies could have made their way through from the surrounding medium.'

"Nothing is easier for us than to discover such organisms within the very centre of the organs of dead animals whenever the parts begin to exhibit signs of putrefaction. They may easily be met with in the centre of a mass of brain-tissue, for instance; and M. Béchamp ('Compt. Rend.,' t. lxvi) has also observed that most active *Bacteria* in great abundance are always to be found in the midst of a portion of liver which has been allowed to macerate in water for a day or two. When a section is made through such a mass, the cells in the very central portions are found to be swarming with moving particles and distinct *Bacteria*, though none or very few are to be found in the water in which the portion of liver is immersed. M. Estor has, moreover, found that the cells of the liver in dogs, rabbits, mice, and various kinds of birds, even immediately after death, always contain a number of actively moving particles or mere granules (*microzymæ*), which, according to MM. Estor and Béchamp, have the power of developing into definitely formed *Bacteria*.

I fully believe (with other observers) that after death, or when death is close at hand, such particles may undergo an internal change fitting them for independent life just as milk-globules are able to individualise themselves, and grow into embryo *Penicillia*. The union of two, three, or more of such

granules in linear series has been watched by MM. Béchamp and Estor ('Compt. Rend.,' 1868). At first the granules form chaplet-like series, but these gradually tend to become more cylindrical, so as to produce ordinary *Bacteria* and *Vibriones*. Similar phenomena have been testified to by Signors Crevelli and Maggi ('Rendiconti di Lombardo,' 1868). These observers watched the union of vitelline granules, and saw them gradually fused into bodies which in all respects resembled *Vibrio bacillus*, whilst these in their turn gave rise to distinct *Leptothrix* filaments. Precisely similar changes were subsequently followed out by the same observers within epithelial cells taken from the back of the tongue of a diabetic patient. In this case the granulations of the epithelial cells, by their union in linear series, formed the rudiments of the future independent organisms.

On the other hand, we may watch all the stages by which epithelial cells in an apparently healthy condition become filled with the minutest granules, which subsequently develop into well-formed *Bacteria*, just as particles similarly productive of *Bacteria* may be seen to appear within the substance of dying Amœbæ. If healthy-looking epithelium cells from the inner side of the cheek be mounted and kept in a warm damp chamber, in the course of from twelve to twenty-four hours a multitude of isolated and motionless specks make their appearance and speedily develop, within the substance of the cell, into well-formed *Bacteria*. This takes place when no notable amount of *Bacteria* exists in the surrounding fluid; and, indeed, from the mode of appearance, distribution, and development of the particles within the cell, it is obvious that, on the "germ theory," we should have to believe that each epithelial cell which goes through this transformation is saturated with as many invisible germs of *Bacteria* as would correspond to the motionless and scattered organisms which are subsequently imbedded in its substance. In their earliest stage these units do not multiply; and before the contents of the cell fluidify, their relative positions are maintained and may be well observed.

Thus, then, we have the possibility of independent organisms arising within unhealthy or dying cells, either by means of a heterogenetic modification of some already existing particles or globules, or by a process of new birth in the fluid or semi-fluid matter of the cell. By one or other of these modes, we believe that the various Fungi and other allied organisms, which are so frequently met with in the bodies of animals as well as of plants, are capable of arising *de novo*.

In the moister mucous membranes, *Bacteria, Vibriones,* and *Leptothrix* are most abundant; and, more rarely, larger Fungus-germs occur, which soon develope an abundant mycelium, as where *Oidium albicans* is produced in the affection commonly known by the name of "thrush." These various organisms exist abundantly enough in almost all the mucous membranes of the body, more especially when there is some unhealthy mode of action going on in the part; and their prevalence in these situations is far more dependent upon the presence or absence of such conditions than upon the degree of exposure of the part to the possible contaminating influence of germs derived from without. Some of those which are least exposed are most prone to throw off the organisms already mentioned, as well as Monads and other more animalised forms.

Fungus-germs and rudimentary mycelia are also frequently met with upon and in the superficial layers of the skin of man and the lower animals, where they represent the best known characteristics of certain familiar diseases.

Here again, as in the case of the mucous membrane and of the general parasitic diseases, there is the possibility that such growths may be occasioned by actual contact with some disseminated and all-pervading Fungus-germs. We know, indeed, that these parasitic diseases are contagious; that persons free from such maladies may become affected, provided the infecting germs fall upon suitable situations and find these in a condition favorable to their growth. Even here, however, the conjoint influence of predisposing and exciting causes of disease must come into play. So that the question is whether, in certain cases, the "predisposing" causes may not be sufficiently potent to generate the disease, without the aid of any "exciting" cause in the form of preexisting Fungus-germs. Much evidence of a general character, in addition to the many facts and observations already alluded to, tends to favour this view—more especially in the face of the almost insuperable difficulties which beset those who are exclusive advocates of a "germ-theory."

The Blood in Syphilis.—At the meeting of the Gesellschaft der Aertze, in Vienna, on January 12th, Dr. Lostorfer related the results of some researches which he had made on the blood of syphilitic persons. Hallier, he said, had described microscopic fungi as being present in the blood in infectious diseases; but his observation had been contested by others. This, Dr. Lostorfer believed, arose from the quantity of blood examined having been too small, and from the investigations having been

made on fresh blood. In August of last year he commenced his researches on blood placed at his disposal by Dr. Zeissl; and in syphilitic cases he constantly found, after three or four days, small glittering corpuscles, sometimes presenting projections. These bodies multiplied themselves by gemmation, new corpuscles being thus formed, which in their turn underwent further proliferation. The addition of various fluids, especially sugared water or Pasteur's solution, produced shrinking of the corpuscles. The corpuscles finally became surrounded by vacuoles. This appearance was found so constantly that he could, from the formation of these corpuscles only, diagnose with certainty the presence of syphilis. On eight or ten occasions he had examined blood furnished to him by Professors Stricker and Hebra; and he had always been able to separate the specimens of non-syphilitic from those of syphilitic blood. He hence named these bodies syphilis-corpuscles. With regard to their number, sometimes more than fifty were seen in the field of the microscope, sometimes fewer. The time of their appearance varied; sometimes they were seen on the third or fifth day, in many cases at the end of twenty-four hours. A low temperature prevented their development; but it went on without impediment in a temperature ranging from 50° to 64° Fahr. He had not been able to determine whether the corpuscles were newly formed in syphilitic blood, or whether their germs pre-existed in the blood, and were only called into activity by the disease. Dr. Lostorfer related a number of cases of secondary and tertiary syphilis in various stages, on which he had made observations. It was remarkable that, in those patients who were improving under antisyphilitic treatment, the corpuscles diminished, and at last disappeared. Professor Skoda congratulated Dr. Lostorfer on his discovery, and regretted that it could not be rewarded with a prize, as would be the case in Paris. Professors Stricker and Hebra also spoke a few words in confirmation of Dr. Lostorfer's statement. Dr. Hebra suggested the examination of the blood in smallpox, in order to ascertain whether it presented any specific diagnostic signs.

The matter again came under discussion at the meeting of the Society on February 9th. Professor Wedl opened the proceedings by contesting the accuracy of Dr. Lostorfer's deductions. Dr. Lostorfer's discovery, he said, would be of great importance if it were confirmed. He (Dr. Wedl) had made some researches, and would now give the results. Dr. Lostorfer had asserted that he could with certainty determine the presence of syphilis from an examination of the blood;

and, in confirmation of his statement, he had adduced the results of experiments on blood placed at his disposal by Professors Stricker and Hebra, who had spoken in confirmation of the remarks of Dr. Lostorfer. Dr. Lostorfer ought to have examined healthy blood with as much care as that of syphilitic patients. Dr. Wedl had examined specimens both of syphilitic and of healthy blood; and in both he had found the corpuscles described by Dr. Lostorfer. —*British Medical Journal.*

Improved Method for the Microscopic Examination of Urine, &c.—Whatever can diminish his labour and save his time must be welcome to the busy practitioner. The ordinary method of examining urinary deposits microscopically entails a considerable expenditure of both; and the process has generally to be repeated several times in order to discover all the characters of the deposit. By the use of the simple contrivance of a "submersion tube," first described by Dr. Dudgeon, in Vol. XI of the 'Quarterly Journal of Microscopical Science,' this labour is greatly diminished, and a large quantity of the urine can at the same time be examined at one operation. The submersion tube is simply a brass tube closed at the end by a thin plate of glass, which is screwed on to the objective, so that the latter may be dipped into the fluid under examination, which is contained in a glass tank or trough placed upon the stage of the microscope. The urinary deposit is, in most cases, quickly thrown down upon the bottom of the trough, and thus the examination of a large quantity of urinary deposit is at one time made quite practicable. The advantage of such a plan as this will be apparent in many cases; as, for example, in the urine of patients suffering from contracted granular kidney, with few renal casts.

The only points to be attended to in the construction of the submersion tube are, that the length the tube projects beyond the object-glass shall be less than the focal distance of the latter, and that the thin glass plate shall be cemented to the brass tube in a perfectly water-tight manner. As the fluid in the trough must be kept horizontal, the microscope of the ordinary construction must, of course, be used perpendicularly, so that if we wish to be seated while making our examination, the microscope should commonly stand on a low table, or a common wooden chair. Objectives of various powers, fitted with a submersion tube, are very useful for examining minute aquatic, vegetable, and animal organisms in a considerable quantity of fluid. They are especially adapted for watching the development of the ova of fishes,

amphibia, and molluscs, for examining the circulation in the transparent membranes of fishes, and for all other purposes when it is necessary that the object under examination should be immersed in a considerable quantity of fluid. The examination of vomited matters, neglected as a rule by practitioners, will be, in some instances, also greatly facilitated by Dr. Dudgeon's submersion tube.

Mr. Adie, of Pall Mall, or any other optician, can make a submersion tube to fit on to an objective of any power up to a quarter of an inch, and perhaps even to objectives of higher powers, though, for ordinary purposes, it is not necessary to go beyond the quarter-inch objective. It is scarcely necessary to remove the submersion tube when examining objects in the ordinary way between two plates of glass, for the thin glass plate that closes the end of the tube does not appreciably affect the distinctness of definition of the object seen through it. The glass trough should be made of pieces of plate glass cemented together with marine glue. For examining urine it need not be more than two inches square and one inch deep. We are of opinion, from a careful trial with the submersion tube, that its advantages are such as to encourage and simplify the use of the microscope in the wards and in private practice.—*Ibid.*

QUARTERLY CHRONICLE OF MICROSCOPICAL SCIENCE.[1]

HISTOLOGY.

IV. Epithelium.—Bizzozero ("On the Structure of Stratified Pavement Epithelium," 'Moleschott's Untersuchungen', vol. xi, p. 30, 1872) discusses the bristle-like processes of epidermic cells from the Malpighian layer, first observed by Schrön, and afterwards described by himself and Max Schultze. Bizzozero had first adopted the explanation that the bristles of adjacent cells interdigitate with one another, so as to attach their cells more firmly together, but has lately been led to a different conception. His observations were made partly on normal epidermis (which he suggests the observer may conveniently obtain with a sharp razor from his own skin, as for instance from the forearm), but better on the hypertrophic epithelium of warts, epithelial growths, &c. After hardening in bichromate of potassium and alcohol, fine sections were made which were stained in carmine and put up in Dammar varnish. It then becomes apparent that the cells are not absolutely in contact, but are separated from one another by a pale border, which corresponds to a very minute intercellular canal, so that the whole forms a canalicular network in each mesh of which an epithelial cell is enclosed. On examination with a higher power these canals are seen to be crossed transversely by the rigid processes or bristles which pass from one cell to the other. These bristles are not, as Schultze supposed, in contact with one another, but separated by intervals which in normal skin, &c., are not wider than the bristles themselves, but in hypertrophic epidermis are sometimes two or three times as large. These intervals are very evident when instead of a profile or sectional view the surface of the cell is examined. The intercellular spaces are of course not really canals, though appearing as such in sections, but correspond to the shape of the cells. What substance is contained in these passages could not positively be made out, but Bizzozero believes that they serve to carry nutritive fluids to the non-vascular epidermis or stratified epithelium.

[1] The editors will be glad to receive, for the purpose of making this record more complete, copies of separate memoirs or reprints from periodicals, which must otherwise often escape notice.

V. Connective Tissue.—Boll, "The Structure and Development of Tissues." [Of this paper, to which we referred in our last, the following is an abstract, taken from 'Centralblatt,' No. 47, 1871.] The investigations recorded in this paper are concerned with the connective tissue substances, and especially with their development; the three sections now published deal with (1) Tendon ; (2) Fibrillated connective tissue.

(1) *Tendon.*—For the study of this tissue in its embryonal condition Boll made use of embryoes of the common fowl from the eighteenth to the twenty-first day; as well as rabbits, guinea-pigs, and dogs, from the last third of intrauterine life, studying especially the centrum tendineum deprived of its serous coverings. When the fibrous bands are examined, either fresh or preserved in Müller's solution or pyroligneous acid, it can be seen that between the parallel bundles of fibres here and there are inserted darker and granulated stripes composed of flat cells arranged close together, precisely in a straight line. When isolated they are seen to be rectangular and rhomboid elements, with coarsely granular protoplasma and generally distinct nucleus, and are further specially characterised by a bright stripe with dark granules (called by the author the "elastic stripe") which runs sometimes along the edge, sometimes in the middle, but always in the direction of the greatest diameter, and through the whole length of the cell. The connection of the cellular plates and the chain formed by them to the fibrillæ, Boll believes to be shown by longitudinal and transverse sections to be as follows:—that the cell plates are cemented to the surface of the bundles and embrace them in the form of a half-complete sheath.

In the study of the completely developed tendon Boll followed Ranvier in using the minute tendinous threads from the tail of young Rodentia which could be examined without any further preparation. The object was fixed by sealing-wax, and an acid solution of carmine added, which had the effect of bringing out here and there between the homogeneous fibrillæ intensely coloured stripes parallel to the long direction of the tendon which were straight, or else more or less curved according to the degree of tension of the tendon. These stripes were made up of segment, separated by hardly perceptible boundary lines, each of which segments corresponds to the stripe called by Boll the elastic stripe, of each individual cell. This stripe was very intensely coloured by the carmine, while the rest of the cell, even the nucleus, took a very faint colour. When the tendon is much contracted (being little stretched, or not at all) the stripe appears, not

as a line, but in the shape of a comparatively broad band with closely-set transverse lines. Just as above described in the embryo, so also in the adult tendon, Boll observed that the cells more or less completely surrounded the fibrillar bundles; and thus is in opposition to the views of Ranvier, who regarded the cellular stripes as hollow cylinders, consisting of a number of superimposed tubular elements, each formed of a single cell rolled up so that its opposite edges meet. Boll contends that it has never been found possible to fill these supposed "plasmatic channels" by injection or imbibition, and relies also on the fact that closed hollow cylinders and others entirely or partially open are never seen in the same preparation; the cells always have the same form and the same relative dimensions. This must naturally be the case if, as Boll (agreeing with Güterbock) supposes, the plates are always stretched out upon and closely applied to the bundles, and the variations in size of the cells, sometimes longer, sometimes shorter, depend upon the degree of tension to which the object is or may have been exposed. That is to say, when the tension is very high, the cells will appear as quite narrow staff-shaped bodies; if less extended they are rectangular, and when the tendon is contracted, as after the application of acetic acid, they are more or less nearly square. This explains also the variable appearance of the "elastic stripe" the changes of which are thus comparable to those in an india-rubber band when pulled out and allowed again to contract.

Beside the incomplete cellular investment of the fibrillar bundles just described, there is also a fibrous investment, the presence of which has long been known through the intense colour assumed by the peripheral parts of the bundles with carmine. According to Boll's observations, there is a direct continuity between the cellular plates and the remaining fibrous vesicular system of the fibrillar sheath, the substance of the former becoming more and more homogeneous, and gradually passing into the latter. A progressive diminution of the cellular and increase of the fibrous constituents of the investment is found to take place with great regularity corresponding with advanced age. With respect to the elastic fibres which are found in the fibrillar bundles, Boll adopts Virchow's view, that they are outrunning processes from cells. This view was supported by finding numerous delicate and often extraordinarily long processes coming off from many cell-plates, which agreed in their size and appearance with the intra-fascicular elastic fibrillæ. It was notable also that these elastic fibres were sometimes absent, some-

times present, in individual bundles, without any fixed rule, and just in the same way as those peculiar processes on the cell-plates were by no means always present.

(2) *"Cartilage" in the Achilles Tendon of the Frog.*—Boll denies the existence of cartilage in this organ, explaining the elements of the structure which has been thus designated as analogous to the elastic plates of the tendon. He describes them as large polygonal cells, very abundantly distributed among the broad and closely interwoven bundles; the cells are arranged in unbroken series on the surface of the bundles, and agree precisely in size and character with the cell-plates in the tendons of mammalia, being mostly homogeneous, with a large distinct nucleus.

(3) *Bundles of Fibrillar Connective Tissue and their Sheaths.*—Two views have more especially predominated with respect to the existence of sheaths round fibrillar bundles. According to one view (that of Henle and Rollet) each bundle is only partially invested by spiral, or at most reticulated fibres. According to another (that of H. Müller, Reichert, &c.), there is a complete investing sheath, which is liable to tear after the application of acetic acid, and then produces the appearance of hoop-like contractions of the bundle.

Boll investigated chiefly the arachnoid of the brain, which was examined either fresh or preserved in Müller's solution, &c., coloured with acid solution of carmine (acetic acid or picric acid solution) and placed in glycerin. On treatment with acetic acid and carmine, each bundle appeared to be clearly surrounded by a sheath, which separated at various points, and left a definite space between itself and the fibrillar bundle. The substance of the sheath is in the main homogeneous; but with a high magnifying power various stripes and trabeculæ, mostly transverse, may be distinguished, as well as nuclei, which for the most part occupy the centre of such a system of fibres. From the comparison of a large number of objects, Boll concludes that the structure of this tendon agrees precisely with that of the membrana propria of acinose glands, as described by him. In the one, as in the other, there is a quite continuous and uninterrupted membrane, consisting of a number of stellate, nucleated cells, fused together, and passing quite imperceptibly into one another, this membrane enclosing, in the one case, the acinus, in the other the fibrillar bundle.

The processes uniting these cells are thicker than the membrane itself, and thus form projections like a grating. The parts thus strengthened will often escape the rupture, which, in consequence of the swelling up of the fibres under

the influence of acetic acid, other parts undergo, and thus the appearance of an interrupted membrane is produced. While this is the usual structure, there may be parts where the nuclei and fibres are entirely wanting, and an appearance may thus be produced corresponding to the descriptions of Reichert and Müller; if, again, such a membrane as here described should be perforated at some points, a reticular structure would result, such as described by Rollet and Henle.

Sometimes a more or less incomplete investment of the bundle, by means of flat polygonal cells, is seen, which often show a transition to a stellate form, and the processes of which also pass into the substance of the membrane. The gaps left in the sheath Boll believes, at all events, in part belong to the original structure. Finally, there are some bundles which are covered with small coarsely granular and protoplasmatic cells, corresponding in shape to those which have been described as occurring in different parts of the eye by Leber, Iwanoff, and Rollet. It has been suggested by the latter observer that such cells may be white blood-corpuscles; and Boll, in order to throw some light upon this question, which could not be decided by hardened preparations, made some observations by means of the hot stage, but could not arrive at any positive conclusion.

Development of Fibrillated Connective Tissue.—The second part of Boll's researches is occupied with the question of development of connective tissue, and especially the much-disputed point whether the fibres are, as originally supposed by Schwann, formed by a metamorphosis of the cell itself, or whether from the amorphous intercellular substance?

His investigations were chiefly conducted on the embryoes of birds, especially the common fowl and the sea-gull. The mammalian embryo was not equally suitable on account of the necessity of using perfectly fresh, still warm objects. The fowl's embryo was found to be suitable for observation only for a single hour. The examination was conducted on small fragments immersed in amniotic fluid.

The cerebral arachnoid, which was one of the tissues studied, was found to consist, on the third day of incubation, of closely set elongated cells, which showed at each pole something resembling a short fibre. On the fourth day, in isolated cells, the terminal parts of the cell show no longer a purely granular protoplasma, but small rough fibrillæ are seen to extend between the single granules. Later on the cells become more and more widely separated, while a perfectly clear homogeneous mass, the "intercellular sub-

stance," makes its appearance between them. This, however, is simply fluid, and differs from ordinary serum only in containing mucin, in addition to its ordinary components. Boll regards it as a transudation from the vessels, and in its amount proportional to their development. It has, therefore, simply a local relation to the cells.

About the seventh day and a little later the formation of fibre is extended over the whole cell, and single fibrillæ may then be traced from one end to the other of the cell, and further still outside it, even running by or through three or four embryonic cells. It appeared most probable that this results from the union or fusion of the several divisions formed in different cells, not by the excessive development of a single one. Beside these longitudinal fibres there are, however, transverse ones, which unite adjacent cells to one another. No spontaneous movements or changes of form were ever seen in the lines of granules situated between the fibres, and Boll, therefore, concludes that the amœboid properties of the residual protoplasma no longer exist after the commencement of fibrous metamorphosis. Further, in accordance with this negative result, it was observed in later stages of development that these interfibrillar masses of granules remain isolated from the rest of the protoplasma of the cell.

Since the fibrous transformation of the embryonic connective tissue cells begins at a time when the vessels are very scantily developed, the latter cannot be regarded as having any determining influence upon the process. On the other hand, as soon as the first set of vessels is formed, Boll believes that most of the connective-tissue-cells actually arise from vessels. He arrives at this conclusion from the very great abundance of vessels in the tissue, from the large number of migratory cells which are attached to them, and finally from the circumstance that the formation of fibres takes place earliest and most vigorously in the adventitia, and gradually spreads thence towards the centre. After the tenth day numerous minute fatty molecules appear, both in the connective-tissue-cells and in the migratory cells, which gives to the central (still protoplasmatic) portions more and more the aspect of granule-cells. The cells, at the same time, come into closer contact with one another, the intercellular substance disappearing till, on the seventeenth day, it is hardly to be seen.

Quite similar conditions may be traced in the subcutaneous tissue of the scalp and of the extremities. Here, however, the intercellular fluid is never so abundant as in the

arachnoid, and the cells are of a rounder shape, so that the formation of fibres takes place rather in all directions than in any particular one.

In the tendon the cells lie not only at first but permanently very close together; and hence the difficulty in making out the relations of fibres to cells. In general, the appearance is that of a band composed of parallel fibres, in which are imbedded numerous nuclei; but here, also, in favorable objects it may be clearly made out that the fibrillæ compose the body of the cell. As, however, the development of fibres takes place chiefly on one side, ultimately, when the cell and the fibres are distinct, the former seems as if applied to the side of the latter.

It seemed here also as if long fibres were made up by the union of numerous shorter segments. No granule-cells are seen in tendon, and thus there appears to be an important difference between the development of this tissue and that of the arachnoid, and, in consequence of this, the embryonic cells do not, as in the arachnoid, disappear, but remain attached to the fibrous bundles as above described.

Tendon.—Török ('Centralblatt,' No. 5, 1872, p. 66) has published a preliminary notice of researches on the Achilles tendon in the frog, enumerating the following points:—(1) He agrees with Boll in rejecting Ranvier's "tubes cellulaires." (2) He finds the technical precautions recommended both by Ranvier and Boll, in regard to stretching the tendon, fixing it with sealing-wax, &c., quite unnecessary, nor does he think the difference in structure between the lax and tense tendon of any importance. (3) The cells are not so peculiar as to deserve any special name, such as "endothelioid," and the "elastic stripe" of Boll is simply a *fold*. (4) The peculiar structure resembling a sesamoid bone in the Achilles tendon of the frog is true cartilage, both anatomically and chemically, but differs a good deal in different species of frog; it is sometimes ossified. According to the author, Henle twenty years ago was inclined to adopt the hypothesis of cellular tubes in the tendons put forward anew by Ranvier, but rejected it on further examination; and in the same way recognised and correctly described Boll's "elastic stripe" as a fold.

Ponfick ('Centralblatt,' No. 8, 1872) has published a preliminary notice of some researches on tendon, chiefly with reference to the views of Ranvier and Boll. He agrees in the main with the results of Török, given above, but suggests another explanation of the "elastic stripe" of Boll, also believing it to be an optical illusion. He believes the lateral

thickness of the curved cellular plate to produce, when seen either from the side or from the front, the appearance of a stripe ; and thinks that a folding of the cell could only rarely produce such an appearance.

Bizzozero (" On the Structure of Tendinous Tissue," 'Moleschott's Untersuchungen,' vol. xi, p. 36, 1872) recapitulates the results of researches chiefly published in Italian journals in the years 1865 to 1868; and of a later series of investigations, of which only preliminary notices have as yet appeared. The two questions which he especially set himself to solve were, whether the *saftcanälchen* (plasmatic canals) of Recklinghausen really exist, and if so, what do they contain? The appearances first described by this histologist as produced by silver solutions were seen by his methods, and also by others, viz. by the use of iron solution with ferrocyanide of potassium, producing a deposit of Prussian blue in the tissues (a method first used by Leber for the cornea); by chloride of gold, and without any colouring, merely by adding very dilute acetic or sulphuric acid. By all these methods he saw the figures described by Recklinghausen, viz. pale figures in a deeply coloured field, connected by small channels or processes. In the tendon these figures are elongated, corresponding to the long axis of the tendon, and measured ·07 to ·1 mm. long by ·009 to ·011 mm. wide. The slender tendons from the hind foot of the frog were used without any preparation, but sections of human and other tendons gave corresponding results.

The second question to be determined was whether these spaces are simply channels for the conveyance of plasma, which may occasionally contain cells, as supposed by Recklinghausen, or whether they correspond to a network of protoplasmic bodies. In order to decide this question isolation of the cells is necessary, and this can only be done by lacerating or tearing out the tissue. This test had in fact been already applied by Langhans soon after the publication of Recklinghausen's researches, and had yielded to the former observer only very small spindle-shaped cells, by no means corresponding to the shape of the silver figures. Bizzozero isolated the cellular elements by macerating the tissue in Müller's solution for two or three months, or else for a shorter time in osmic acid or chloride of gold. The cells which he thus obtained were large, flat bodies, exactly corresponding to the figures produced by silver and other methods. Their shape is very irregular, though often elongated in the direction of the nucleus, but chiefly remarkable for its extreme tenuity, appearing in profile like a mere line. They

are, in fact, true nucleated cell-plates like those described by Hoyer and Schweigger-Seidel from the cornea. For the most part they have no processes. The size varies considerably, but is generally greater in adult or old individuals than in young ones. Cells from the tendons of the frog measured ·1 mm. long by ·01 broad, and the nucleus ·03 mm. by ·007 mm. In the Achilles tendon or ligamentum patellæ of old men some remarkably long cells were found. One cell measured ·168 mm. long by ·003 mm. wide, and its nucleus ·05 mm. by ·0025.

On the whole, Bizzozero concludes that the spaces are occupied completely by fixed cells connected by anastomosing processes. In the Italian version of his paper he states that he has been quite unable to confirm the results of Ranvier. Of other recent memoirs he takes no notice.

Development of Vessels.—Klein has published ('Sitzungsberichte der Wiener Akad.,' Bd. lxiii, Abth. 2) an important memoir on "The middle germinal layer and its relations to the first blood-vessels and blood-corpuscles in the embryo of the common fowl." The memoir consists of two parts. The first part, after a long and elaborate historical introduction, treats of the development of the middle layer in the germinal membrane of the fowl's embryo; while in the second is shown how blood-vessels and blood-corpuscles are developed out of special elements in this layer.

If the germinal disk of unincubated eggs laid in spring be divided into thin sections, it is easy to convince oneself that the central part is in many respects different from the periphery; that is, from those sections corresponding to the *area opaca;* the central part of the disk appears to consist over a considerable area of two layers, which are at some places separated by an interval, at others lie close together. The cellular elements arranged like an epithelium in the upper layer are cylindrical, finely granular, and distinctly nucleated; the less closely arranged and somewhat larger cells of the lower layer are roundish and coarsely granular, for which reason a nucleus can only rarely be seen in them. In its peripheral parts the germinal disk is quite otherwise constructed: the two layers are here so closely united that a separation of the elements into groups is not conceivable; the cells are also actually larger, and hence the disk is thicker at the periphery than in the centre; it appears to be made up of large globular bodies with distinct and brilliant granules.

Similar coarsely granular spherical elements which lie on the floor of the segmental cavity, and are arranged together

in a chain, are attached to the peripheral parts of the germinal disk (the formative elements of the middle layer, Peremeschko). Oellacher has shown that they are to be regarded as elements produced by segmentation as derivatives of the germinal disk, which during the formation of the segmental cavity remain behind on its floor. With respect to the changes in the germinal disk which take place when incubation commences, and more particularly with respect to the participation of the last-named elements in the formation of the middle germinal layer, Klein confirms essentially the statements of Peremeschko. That is to say, these cells divide, and the small cells derived from them, which are easily recognised by their large nuclei, penetrate (first of all in the centre of the area pellucida) into the space between upper and lower germinal layer. Klein decisively rejects the theory of His, that the middle germinal layer which arises in the first day of incubation between the upper and the lower is formed by the proliferation and horizontal extension of the sub-germinal processes. On the contrary, the derivatives of the formative elements of the middle layer migrate from the outside of the disk between the two germinal layers towards its centre.

When at the end of the first day of incubation a distinct and continuous middle layer is thus completely formed between the upper and lower layer in the manner above described, contemporaneously with the production of the primitive groove, then next begins a considerable enlargement and thickening of the middle layer, proportionate to the enlargement outwards of the upper layer. During the whole period of growth and till its actual completion the middle layer forms no anatomical connection with the upper layer or with the white yolk of the germinal wall. Much stress is laid upon this point, as opposed to the theory of His, about the reception of parablastic elements into the germinal disk from the white yolk.

After these general considerations, Klein proceeds to describe the histological facts which he has observed in the development of blood-vessels and formation of blood-corpuscles as seen in fresh objects by a surface view. All stages of this development may be traced in the area pellucida of almost any germinal disk which is fresh and carefully put under the microscope in the first half of the second day of incubation.

The three following series of changes are distinguished:

(*a*) Some of the cells of the deeper layer of the germinal disk become hollow by the formation in them of a vacuole, and by enlargement of the vacuole are transformed into

vesicles, whose wall is the original body of the cell. From the nucleus, which is at first simple and clear, several oblong nuclei arise, which separate more and more from one another in proportion as the vacuole increases, till they are ultimately arranged at pretty regular intervals. The wall of the cell at this stage is compared by Klein to an endothelium, and the vesicles he calls "endothelial vesicles." Cells which are some of them coloured, some white, are separated from the protoplasmic wall of the vesicles (which is the endothelium of the future blood-vessel) and are contained in the interior of the vesicles.

(*b*) The substance of some other cells shows a yellow tinge round the one or two centrally situated nuclei; and later on the central part of the cell substance distinctly splits up around the nuclei, so that none but coloured nucleated blood-corpuscles are contained in the interior of the cell.

(*c*) Certain coarsely granular formative elements become altered in such a way that when the coarse granular appearance is gone and a multitude of nuclei have come into view the central part of the protoplasmic substance becomes yellowish, and becomes marked off as blood-cell substance, while the peripheric part of these elements represents the protoplasmic wall, the endothelium of the future vessel.

In all these three cases blood-corpuscles arise by an endogenous process from the central part of certain cells of the middle germinal layer, while at the same time a protoplasmic and regularly nucleated wall (endothelial wall) is formed out of the peripheral part of the same cells.

It is also shown how a closed tubular system, the vascular system, arises out of these germinal cells containing blood-corpuscles. The vesicles which are at first round grow out into an elongated shape, or swell out in various directions as they grow, while at the same time they come considerably nearer to one another. The wall of these vesicles often sends out solid threads and shoots which afterwards become hollowed out, and into the cavity of which the cavity of the cells containing blood-corpuscles is continued. In this way there arise irregular branched and vascular structures which become transformed into a continuous system of tubes by the connecting threads which pass from one blood-cell to another becoming hollowed out. In this way results a system of tubes forming a network, and filled though not uniformly with blood-corpucles. The cavity of the heart, the aorta, and the *sinus terminalis*, arise according to Klein's observations in the same way. He finds that the earliest blood-vessels both of the area opaca and the area pellucida, are developed

in that part of the middle germinal layer which has received in the area pellucida the name of the intestinal fibrous lamina of Remak.

Finally, statements are made respecting the differences perceptible even in the embryo between arterial and venous vessels; the former possessing even on their first appearance beside an endothelium, a wall closely attached to this, composed of branched cells.

VI. Nervous System.—Stieda (Schultze's 'Archiv,' viii, p. 274), on the supposed terminal corpuscles in the hairs of some mammalia, calls in question the function assigned by Schöbl in his description of the bat's wing and the mouse's ear, to certain structures which he calls terminal nervous corpuscles or end organs. Stieda recognises the existence of these bodies, only believes them to be not nervous at all, but hair-germs or the first indication of new hair. He has seen them on various parts of the body of mammalia, but very variable in number, according as the individual animal was or was not going through a change of hair.

VII. Organs of Sense.—1. Gottstein contributes to (Schultze's 'Archiv,' (viii, 145) a paper on the minute structure and development of the auditory labyrinth, &c., in man and mammalia. He describes more particularly the human organ, and compares it with that of other animals.

2. Nuel has a paper on the same subject in the same journal (p. 200). He discusses specially the striation of the membrana basilaris, and the course of nerve-fibres in the canalis cochlearis. Both memoirs are very beautifully illustrated.

X. Digestive Organs and Glands.—1. Heidenhain, in a short note (Schultze's 'Archiv,' viii, p. 279) states that changes dependent on functional activity have been observed in Brünner's glands, similar to those observed in the glands of the stomach and pylorus.

2. Schwalbe (Schultze's 'Archiv,' viii, 269) discusses the question whether milk-globules have a membrane, and arrives at the conclusion that they consist of, beside fat, an albuminous substance placed externally after the manner of a membrane.

3. Friedinger ('Sitzungsberichte der Wiener Akad.,' Bd. lxiv, 2 Abth., October, 1871) has studied the different forms of cells distinguished in the gastric glands by Heidenhain and Rollet, in relation to the question which class of cells contain pepsin. In general he confirms the results obtained by the two observers just named in the case of mammalia, and also found, as they did, that in frogs and tritons one class of cells

only exists—those, namely, distinguished by Heidenhain as "investing cells." The same was true of the tortoise; but in this animal the pyloric glands differ much from those of the rest of the gastric mucous membrane, containing, up to the very end, cylindrical cells, while the others are filled with "investing cells." The stomach of a snake (*Coronella lævis*) showed also investing cells at the closed ends of the follicles; but in the neck of the gland large vesicular cells, like those described by Heidenhain in the peptic glands of the frog, and regarded by him as mucus-cells. In order to test the hypothesis of Heidenhain, that the investing cells secrete acid only, while his "capital or chief cells" produce pepsin, Friedinger made certain experiments on digestion, the general result of which was to contradict Heidenhain's hypothesis, as well as the confirmatory experiments of Ebstein, who had sought to prove that the pyloric glands, which contain, according to him, cells analogous to the investing cells of the gastric glands, also produced pepsin.

Friedinger, repeating the same experiments more carefully, found the pyloric glands to possess little or no digestive power, while he considers their cells as comparable to the chief cells of the gastric glands, and, accordingly, is led to a hypothesis precisely the converse of Heidenhain's, namely, that the cells usually described by previous authors as peptic cells are really those which produce pepsin, though it is to these that Heidenhain gives the name of investing cells, and ascribes the production of acid only.

XI. Muscle.—Merkel (Schultze's 'Archiv,' vol. viii, p. 244, 1872) has published a careful memoir on striated muscle, confining himself for the present to the Arthropoda. In a short historical notice he mentions the new interpretation given by Krause, who, seeing a line in the singly refracting substance of muscle, regarded it as a transverse disk, dividing the substance into two halves, so that a single muscle element consists according to him of one half a mass of singly refracting substance, a whole doubly refracting portion, and again one half singly refracting. This whole series is enclosed in a sort of box, or muscle compartment formed by a membranous tube closed at each end. In Hensen's memoir, published about the same time, this observer also claims to have discovered a new transverse disk, only this time not in the singly but in the doubly refracting substance. He thus regards the muscle element as made up successively of *one half* doubly refracting substance, *one* singly refracting, and, again, *one half* doubly refracting. It would be easy to identify these views if we could suppose that one or the other

had confused the optical properties of the substances, and described the singly refracting as doubly refracting, or *vice versá*, but both guard themselves against such a supposition, and contribute explanations and suggestions of sources of error. Next, to bring the confusion to a climax, appears a new paper by Heppner, who regards both views as incorrect, and pronounces the newly discovered transverse line to be singly refracting, everything else to be doubly refracting. All other marks and stripes of the muscle are, according to him, due to optical illusions, and have no value. Merkel in his own investigations used almost entirely alcohol, other reagents being found much less advantageous. He worked more particularly on the thoracic muscles of insects. When examined fresh these show few or no transverse bands, but placed in fresh white of egg the striation becomes very obvious. In other reagents, the fibres appear mostly homogeneous. Hardened preparations cannot be advantageously made except from muscle which has already undergone rigor mortis. Merkel adopts to a certain extent the explanation of Krause, so far that he recognises beside the true muscle element the following accessory parts:—(1) A tubular sheath limiting the muscle element at the sides, which swells up under the action of acetic acid; the *lateral membrane*. (2) A septum stretched across precisely in the middle of a muscle element; the *median disc* (of Hensen). (3) Membranes analogous to the median disc which close the muscle-element at each end; or *terminal discs*. The two contiguous terminal discs may, for the sake of convenience, be spoken of as one. The terminal discs are the transverse lines described by all previous observers except Hensen, the true contractile substance being hitherto unrecognised.

The chief point in which Merkel differs from other observers is in the contrast which he establishes between the state of rest and state of contraction, and his interpretation of the *homogeneous* fibrils often met with. In a *state of rest* may be seen beside the terminal discs, a dark portion in the middle, which shades off towards either side, being very indistinct, as compared with the terminal discs. This Merkel regards as a solid mass of contractile substance, concealing the median disc, and the rest of the contents of the space enclosed between the terminal discs he thinks there can be no doubt is fluid. When contraction begins, the terminal discs come nearer together (the fibril becoming broader), and at the same time they look thicker; while, in place of the dimly shaded band in the middle, there is a

narrow and sharply defined one. This Merkel explains as the median disc, now exposed to view, in consequence of the contractile substance having moved to either end of the muscle compartment, where by its accumulation it causes the apparent thickening of the terminal discs. Each muscle compartment, then, now contains a portion of solid contractile substance at each end, in close connection with the terminal disks, and a middle zone occupied by liquid and divided by the median disc. Merkel was, after much trouble, able to trace these changes while the process of contraction was going on. The solution of the difficulty was given by certain fibres of the claws of cray-fish, plunged, when quite fresh, in absolute alcohol. In them were seen some quite homogeneous parts, on one side of which the fibre was in the state of contraction, on the other side in a state of rest; and this intermediate homogeneous portion represents the transitional stage between the two. (This Merkel believes to be the true explanation of the perfectly homogeneous fibres often described.) When the key had thus been found, it was possible to trace successively the three stages of rest, transition, and contraction in living fibres also. With regard to the optical properties of muscle, Merkel asserts that, in his "transitional stage," the whole fibril is doubly refracting, and its optical effect shows that it is solid. In fact, there must be at this moment, through the whole of the muscle compartment, an intimate mixture of its solid and fluid contents. The area of each muscle compartment remains, during contraction, precisely the same, as was shown by direct measurement.

"Muscles of the Small Bronchi and of the Lung Parenchyma."—Rindfleisch ('Centralblatt,' No. 5, 1872, p. 65) gives the following preliminary communication on this subject. The smallest bronchi have a very clearly marked layer of transverse muscular fibres, which is strengthened so as to form a complete sphincter at the point where the bronchus passes into the infundibulum. They are susceptible of considerable dilatation, and are furnished just under the epithelium with a very close network of capillary vessels, like those of the lung. (2) The circular muscular bundles of the smallest bronchi send loop-like prolongations into the opening of the infundibula, which penetrate to their extremity. At a few points bands of smooth muscles form rings round the infundibula. These muscular rings lie in those parts of the alveolar septa which project most inwards. (3) All these muscles are hyperplastic in the morbid condition known as brown induration of the lung. When once

recognised in this condition, they can be traced in the normal lung, where they are extremely delicate.

Thread-Cells.—An important paper appears by Eimer (Schultze's 'Archiv,' viii, 281), in which he reports the discovery of *thread-cells* in several species of siliceous sponges, belonging or allied to the family Renierina. He admits that there is something which might almost be called suspicious in a statement which conflicts so decidedly with the accepted zoological classifications, but thinks he has excluded all possibility of error arising from the accidental presence of thread-cells belonging to other organisms, &c. Another important fact is the presence of semen (spermatozoa) in numerous gelatinous, siliceous, and calcareous sponges; though this point Eimer finds that Häckel had observed simultaneously in another place. He does not forget to speak of Huxley's similar observations, made long ago on Tethya, formerly doubted, but now accepted by Häckel; according to Eimer, however, Huxley, and also Häckel, must have observed spermatozoa in an incomplete state of development.

PROCEEDINGS OF SOCIETIES.

Royal Microscopical Society.

January 3rd, 1872.

W. Kitchen Parker, Esq., F.R.S., President, in the chair.

Dr. James Murie read a paper "On the Development of Fungi within the Thorax of Living Birds."

W. Carruthers, F.R.S., read a paper "On the Structure of the Stems of the Arborescent Lycopodiaceæ of the Coal Measures."

A discussion followed, in which Professor Thiselton Dyer, Dr. Braithwaite, and the President, took part.

Dr. Royston Pigott made some remarks upon the advantages sometimes gained by reducing the angular aperture of object-glasses.

On the 24th January an evening meeting was held for the exhibition of objects and apparatus of novelty or remarkable interest, and for friendly conversation. The gathering, in number about 200, was almost exclusively composed of Fellows, with a few visitors of scientific eminence, no general invitations having been issued.

Histological specimens were exhibited by Dr. L. S. Beale, Dr. G. Johnson, Dr. W. J. Gray, Dr. Bruce, Mr. C. Stewart, and Dr. Klein (the latter under Mr. Stephenson's new erecting binocular microscope); other specimens, illustrating natural history, by the President (Foraminifera), Dr. Carruthers, Mr. Gay, Mr. M'Intire, and many others; and various microscopical apparatus by the makers.

February 7th, 1872.

The President (who was in the chair) delivered the Anniversary Address. Disclaiming the position of being an annalist to his fellow-workers, the President proceeded to give a sketch of the different phases of his own labours in the development of the vertebrate skeleton. He showed how, starting with the Paley or fitness school, as represented by Sir Charles Bell, he came under the influence of his old master—"our English Oken"—Professor Owen, who might, he thought, be accused of misleading students, by suggesting an easy solution of all the hard sentences of nature in an archetypal idea, instead of setting them to work with scalpel and lens and microscope.

Transcendentalism, though now justly discarded as a method of morphological research, entangled, not the English workers only, but the great Scotch anatomist Goodsir in its meshes; and his most important paper on the morphology of the skull is a hopeless mixture of observation and speculation. The true foundations of vertebrate morphology were laid by a noble band of workers, with one or two exceptions foreigners, and mostly Germans, of whom Baer, Reichert, and Rathke were the earliest. The importance of their embryological researches was first shown in this country by Professor Huxley, whose Croonian Lecture on the "Theory of the Vertebrate Skull" was delivered in 1858. In this he laid down, as a deduction from the works of the embryologists, that development must be the criterion of the truth or falsity of all speculations on the morphology of the skull, the study of gradations of structure being valuable only in suggesting homologies.

The President then proceeded to speak of his own researches. His paper on the osteology of *Balæniceps rex* was first of all worked out gradationally, but when he became aware of Huxley's innovations he adopted a microscopical and embryological method of research. His further investigations on the development of the gallinaceous birds, and others, had borne fruit in Huxley's paper on the classification of birds, in the Proceedings of the Zoological Society, for 1867. Working on largely with the microscope, he arrived at results, stated in his paper on the fowl's skull, which form a mass of evidence in favour of evolution. The general result is, "that the whole group of existing birds, excluding those half-ostriches the Tinamous, as well as the genuine ostriches, form a mere order, as neat and compact as the Lacertilia among the Reptiles; once a small distance *above* the ostriches, and the life-tree forks and reforks, and very few steps upwards have to be made before we arrive at the most accomplished types; from the Dinornis to the Humming-bird there are but a few and easily traced stages. Also, so far as we know at present, the life-history of each individual of a high type is a repetition of the evolutional progress in the ascent and modification of the vertebrate forms from the beginning."

Mr. Hogg read a report on a specimen of Mycetoma, which was taken as read.

The annual report of the Society was also read, from which it appeared that the Society had been during the past year well supplied with papers; that the collections of books, instruments, and objects were in good condition; and that the financial state of the Society was such as not to call for any special remark.

Sixteen ordinary Fellows and one Honorary Fellow had been elected during the year; and the Society had lost three Fellows by death.

The following Officers and Council were then elected:—

President—W. K. Parker, F.R.S.

Vice-Presidents—*W. B. Carpenter, M.D., F.R.S.; J. E. Gray,

Ph.D., F.R.S.; *Sir John Lubbock, Bart., M.P., F.R.S.; John Millar, F.L.S.

Treasurer—*J. W. Stephenson, F.R.A.S.

Secretaries—H. J. Slack, F.G.S., and Jabez Hogg.

Council—R. Braithwaite, M.D., F.L.S.; J. Berney; Charles Brooke, M.A., F.R.S.; *T. W. Burr, F.R.A.S.; W. J. Gray, M.D.; Henry Lawson, M.D.; Henry Lee, F.L.S., F.G.S.; *S. J. M'Intire; *H. Perigal, F.R.A.S.; G. W. Royston Pigott, M.A., M.D.; C. Stewart, F.L.S.; T. C. White. (Those marked with an asterisk being new names.)

The following gentlemen were elected Fellows of the Society:—Charles Gibson, Esq.; David Johnson, Esq.; William Boyd Moss, M.D.

March 6th, 1872.

The President in the chair.

A communication was read from Dr. J. J. Woodward (U.S.), accompanying some micro-photographs. Dr. Woodward praised highly an immersion $\frac{1}{50}$th objective of Messrs. Smith and Beck.

Mr. Stephenson made some remarks on a new development of his binocular arrangement for the microscope. The chief peculiarity of the new arrangement was that the prisms were sc reduced in size as to be inserted into the object-glass itself, and their angle reduced from 75° to 66·30°. It had the great advantage of being applicable to powers at least as high as $\frac{1}{8}$th of an inch.

Dr. Klein then read a paper on the development of the ovum of the trout (*Salmo fario*). According to the observations of Rusconi, who first investigated this subject, and of Prevost and Dumas (1824), who studied Batrachia, the first step in development consists in the division of the blastoderm into two parts, each of which again divides into two; *i.e.* the whole being then marked by two grooves at right angles to one another, so as to produce a cross, the segmental cross (*furchungs kreuz*). Coste and others observed the same process in other Teleostea. Stricker's results differed somewhat from these, but were obtained by an entirely different method, namely, by making sections. It was objected to this method that the appearances produced might be artificial, and not really belonging to the object, for which reason Klein preferred to study the early stages in the living state. His observations were in perfect accordance with those of Rusconi, Coste, &c., on the points in which they are opposed to those of Stricker. A detailed account was then given of the changes successively observed in the ovum from day to day. The "cross," showing the division of the blastoderm into four parts, was observed in most ova at the end of the first day; after thirty-six hours, two of these quadrants were seen to be divided, and at the end of the second day all the quadrants. After this time no regularity was observed in the process of segmentation; and on the third day the whole blastoderm was covered with irregular

projections. The segmentation was sometimes not complete till after eight days. These statements are in accordance with those of the earlier observers, but not with those of Stricker, who stated that the "cross" was never seen earlier than forty-eight hours after impregnation, and that segmentation was finished earlier than Klein believed. The further developments of the embryo up to the twenty-second day were described. The most important point discovered was the mode of growth of the chorda dorsalis and central nervous system, in which the trout appears to form an exception to other vertebrata. In others, as is well known, two folds grow from the second or nervous layer, which, by their approximation and union, form the nervous canal. In the trout, on the other hand, one solid process grows out from the nervous layer, having the chorda dorsalis beneath it. This process has two projections, corresponding to the *laminæ dorsales* of other vertebrata. The central canal does not, however, appear as an open groove (or *furchungs-spalte*), but as a split in this solid process. This takes place from the seventeenth to the nineteenth day.

Dr. Klein read a second paper, on "The Nerves of the Cornea." The observations described in this paper were, in the main, the same as already published in the 'Quarterly Microscopical Journal,' but were made by a method which, colouring the nerves only, not the surrounding tissues, enables the structure to be made out with a magnifying power of 250 to 300 diameters.

Dr. Klein further replied to some of the statements and criticisms of Dr. Lionel Beale, contained in his articles in the 'Monthly Microscopical Journal' for January and February of this year. Dr. Beale was, he thought, not justified in claiming for himself the discovery of networks of pale or non-medullated nerve-fibres; nor that the networks which he had described were now, though long questioned, accepted by German histologists. The original discovery of networks of pale terminal nerve-fibres belonged to Remak, who observed them surrounding striated muscular fibres. The results of Remak were confirmed by Schaffhausen, in regard to the skin and mucous membrane. Kölliker (in 1856) made similar observations in respect to the mammæ; and Axmann, in the skin of the frog; as did also Meissner (1857), in the submucous tissue of the intestine, and Billroth (1858), in certain parts of the intestinal tract. With respect to the cornea, a terminal network was described by Arnold in 1860, the same year in which were published Dr. Beale's observations on the distribution of nerve to striped muscles; and, also, a network of pale fibres had been observed on the capillary blood-vessels by Klebs, before the publication of Dr. Beale's papers in the 'Philosophical Transactions' for 1863-65.

Beale had, undoubtedly, done much to advance the doctrine of terminal networks; but he had failed to see the *finest terminations*, such as the minute fibres which Hoyer, Cohnheim, Kölliker, and Engelmann, had seen among the epithelial cells of the cornea, starting from the sub-epithelial plexus. These were

however, to be seen with perfect clearness by the use of the gold method, though not in general by carmine, &c., as used by Dr. Beale.

Dublin Microscopical Club.

21st September, 1871.

Saddened by the intelligence of the death of their lamented fellow member, Mr. George Dixon, the Club relinquished the stated Monthly Meeting intended to have been held on the above date; for, although a lengthened illness had for some time deprived the meetings of his genial presence, the members regarded the loss of a valued friend which they had just sustained as too recent, and their sense of it too keen, to hold the ordinary monthly reunion, whilst they felt, too, that such a mark of respect was but a small tribute due to the memory of one so truly and so justly held in high regard and esteem.

19th October, 1871.

Mr. Vickers showed some striking examples of ordinary "pond life" under his microscope, presenting, for those who might not be conversant with such, an interesting "happy family."

Rev. E. O'Meara exhibited and pointed out the specialities of a new Stictodiscus from the "Sulu" material, which he is at present engaged in working up, and the details of which he hoped ere long to furnish.

Mr. Archer showed one or two sketches of new Desmidian species, amongt the most striking of some novelties encountered in a recent visit to Connemara, in company with Mr. A. Andrews, Dr. Barker, and Mr. Crowe. He was endeavouring to work up the material, and would hope to show some further drawings ere long. Some of these forms were exceedingly scanty, and it would be almost hopeless to alight upon examples for display at the meeting. He exhibited, however, a fine form, which he thought he must, at least provisionally, regard as *Docidium nodosum* (Bailey), which would thus be new to Britain, and of this he had encountered only just this single specimen, and that on the evening previous to the meeting, and he at once tried to secure it. Whether correct or not in this identification, this was, at all events, an extremely striking and handsome form, its large size and bold, deeply undulate outline, caused by the four whorls of rounded conspicuous prominences, entitling it to take rank amongst the finest, at least, of British forms. The principal difference between the present and the figure given by Bailey ("Micros. Obs. in S. Carolina, Georgia, and Florida," pl. i, fig. 4) was the existence here of a number of short, conical,

acuminate processes at the apex of each segment, which are not shown by Bailey, but as those do not project beyond the seemingly truncate end of the cell, he may have overlooked them. If indeed this be not correctly referable to *Docidium nodosum* (Bailey), (Mr. Archer need hardly remind that this is not to be confounded with *Docidium nodulosum*, Bréb., a fine but not uncommon species), then indeed it must be a new species, so far as he was aware. But inasmuch as we have no better authority than Bailey's meagre record and rough figure, nor are we likely to obtain any recent specimens from his original localities, it is safer to allow the question so to remain—the form now shown can, *ad interim*, remain *our* Irish *Docidium nodosum*—of course some might prefer to designate it *Pleurotænium nodosum*. Doubtless, there must be more to be had where this solitary example came from, and a search in the same situation may be more successful in obtaining a better gathering on a future occasion. An enumeration of the Desmidian rarities taken on the present visit thither Mr. Archer must defer until the material at command was more fully worked up, and if not the veritable examples in their own fresh beauty, he hoped to be able to present one or two drawings to the Club at the subsequent meeting.

Mr. Arthur Andrews exhibited *Polyphemus pediculus* (Linn) Straus; he had found this peculiar Entomostracan in several of the Connemara lakes on the same recent excursion thither. On one occasion, when "fishing" with a small muslin net in Lough Corrib, some hundreds of these creatures were taken in a single dip in a sheltered sunny creek, whilst further search along the same shore failed in procuring a single specimen. He also showed a drawing of the young as they escaped from the ova, in which the development of the eye with its muscular apparatus was very remarkable. Mr. Andrews also showed *Lynceus elongatus*, *Sida crystallina*, and *Daphnia mucronata*, from the same localities. *Acantholebris curvirostris* was very plentiful in most of the small bog-pools.

Mr. Archer thought it might be interesting to mention that several of the rarer *Rhizopoda* had turned up from the Connemara gatherings, but always very scantily; indeed, even the commoner forms were not at all abundant. To enumerate the rarest in the order of the scarcity of their occurrence in the gatherings hitherto, *Diaphoropodon mobile* (Arch.) might probably come first. Of this form just one example only had as yet presented itself; this was a remarkably fine one, and, when living, its very copious and arborescent tuft of pseudopodia strongly projected, it formed, of its kind, a noble object. This specimen Mr. Archer had treated with carmine fluid and brought it down to the meeting; its large "nucleus," which indeed by some might be doubted to be there when seen living, had acquired a very bright colour, and thus formed a striking feature, whilst the seeming incoherent and indiscriminate agglomeration of external granules could be readily examined. Even though for so far so scantily presenting itself, it was then interesting to extend the

distribution of this form.—The "labyrinthidean-*like*" form (be its *true* nature what it may) once found at Multyfarnham (Co. Westmeath), and once at Glen Ina (Co. Galway), was now again met with, but at present Mr. Archer would only allude to its occurrence.—*Raphidiophrys viridis* (Arch.), as yet found in but three counties in Ireland (Wicklow, Cork, and Westmeath), turned up sparingly near Lough Acclagh, about four miles from the town of Galway, thus making it a denizen of a fourth county.—Of *Pamphagus mutabilis* (Bailey), just two examples favoured search in the gatherings, these as characteristically crammed full of all sorts of food as their brothers down in Co. Westmeath, are wont to offer themselves to view.—*Amphizonella vestita* (Arch.), green and not green, hairy and not hairy, turned up in an isolated manner in two or three gatherings.—*Acanthocystis Pertyana* (Arch.) was once or twice seen—*Clathrulina elegans* (Cienk.) not more frequently offered itself.—Of always interesting, though more common forms than the foregoing, *Pompholyxophrys punicea* (Arch.), *Heterophrys Fockii* (Arch.), and *Acanthocystis turfacea* (Carter) were met with, though more sparingly than they ordinarily are prone to occur in Cos. Wicklow and Westmeath.—Of still more familiar forms—Cyphoderia, Trinema, Euglypha, Difflugia, Arcella,—the supplies also appeared comparatively more scanty than elsewhere, whether due to the time of year or otherwise. Of Difflugiæ, *Difflugia carinata* (Arch.) was amongst the most frequently met with; *Difflugia triangulata* (Lang) occurred exceedingly sparingly (the best place to find this species which has yet been encountered in Ireland is the region behind Carrig Mountain, Co. Wicklow); but, as has been mentioned, not any on this occasion occurred abundantly.

Found amongst the gathering made from Connemara, Mr. Archer had on the table examples of a rare little Alga, taken previously, however, in North Wales and in Co. Wicklow ('Quart. Journ. Micro. Sci.,' vol. VII, p. 298; vol. VIII, p. 68), *Cosmocladium saxonicum* (de Bary). The cells in these specimens were of rather smaller dimensions than those which had previously presented themselves in this country.

Mr. Archer had likewise on the table examples of another minute Alga which he had never before met with, now new to Britain, *Dimorphococcus lunatus* (Al. Braun); however, time did not admit of this being brought forward, but he had little doubt it would last in good condition until the following meeting.

Resolved, that it is with feelings of deep regret we record to-night the death of one of the ordinary twelve Members, that of our much respected friend, Mr. George Dixon. He was one of the few lovers of the Microscope to whom the Club owes its origination, and, although not devoting himself to any special field of microscopic research, contributed greatly to the success of our Association. Though now removed from amongst us, he will live long in the memory of his many friends, who respected and esteemed him for his geniality of nature, frankness of bearing,

sincerity of purpose, kindliness of heart, his high intelligence, and great moral worth.

9th November, 1871.

Dr. Frazer exhibited seven well-crystallized diamonds from Natal; he directed notice to the peculiar brown colouring matter which tinged portions of the edges of two of these diamonds, and especially to black imbedded material not of crystalline form situated deeply within two of the larger crystals; this appeared to be a variety of graphite, or allied to the bituminous substance found in quartz.

Rev. E. O'Meara brought forward some examples of British Amphoræ, stating his opinion that there existed three distinct forms, but that they were erroneously confounded; he was working up the whole subject, and the views he now propounded would hereafter make their appearance in detail.

Mr. Woodworth showed a number of elegant micro-photographs by Colonel Woodward, and sent to him from America by that gentleman. Mr. Woodworth promised to bring before the Club on a future occasion some details of the process as adopted by himself.

Dr. E. Perceval Wright exhibited a series of the calcareous plates met with in the form of rosettes at the base of the ambulacral feet, also of those found in the delicate ovarian membranes of *Echinoneus minor*, and the two forms of Pedicellariæ met with on the external ambulacral region of the same species. He referred to M. Edmond Perrier's researches on the Pedicellariæ and Ambulacra of the Sea Urchins, and regretted that the author had not better worked out the literature of the subject, for, although his memoir is of decided value, it would have been much more so had the labours of his predecessors been alluded to. Among the writers entirely overlooked, might be mentioned Gaudry and C. Stewart; the result of the investigations of this latter worker Dr. E. P. Wright had laid some years ago before the Club. M. Perrier gives a long list of the Echinoida that had been examined by him, including all the species in the Zoological Museum of the Jardin des Plantes, and in his 'Memoir' he mentions that he had never met with specimens of the remarkable genus Echinoneus having spines, and so was unable to determine whether they possessed Pedicellariæ or not. In a supplementary note he adds some details of these structures, as met with in a species of this genus undetermined, and from an unknown locality. From the description given in the note, it is not easy to determine the species, but it is apparently not the *E. minor*, Lesk. All the species of this genus are very rare in a perfect condition, so rare that very few museums or collections possess even solitary examples; hence, there is some interest in having a detailed account of the calcareous skeleton of that species, with minute description of all the calcareous appendages to the corona. Into the supposed uses of the Pedicellariæ Dr. E. P.

Wright did not enter, stating, however, that he regarded them as but modified spines.

Mr. Archer drew attention to some examples of the little Flagellate—*Anisonema sulcatum*, Duj. (written *sulcata* by Dujardin, but doubtless it could not be considered wrong to violate the "canons" of nomenclature so far to alter the name as to make it accord with the "canons" of grammar). This does not seem (in certain localities) a very uncommon organism, and was most likely known to most in the room, though probably not many had been led to identify it; and the reason Mr. Archer would, however, now show it was to point out a speciality which seemed to him to exist, but not before to have attracted notice. Just close to the little notch-like anterior excavation whence emanate the two flagella—one of these, during progression, carried in advance, the other trailed behind—could be seen a somewhat "snout-like" truncate apex, leading away from which down the "body" of the organism could be traced two parallel lines, finally seeming to lose themselves, these lines being quite distinct from the striæ produced by the somewhat oblique or curved longitudinal superficial sulci. These parallel lines seem to be, in fact, the outlines of a *piston-like* (or *stopper-like*) organ, which has the faculty of being drawn in a notable distance (say about one sixth of the length of this organism) somewhat forcibly, and again pushed up, and even occasionally projected appreciably beyond the truncate apex. The extremity of this *piston-like* "organ" seems itself truncate and some somewhat thickened, also less hyaline than lower down. It was not clear, however, whether this occupied what might be called a tubular *socket* or lay in a lateral superficial *groove* for its reception, but at any rate it was not central, but more to one side; still, appearances were seemingly more in favour of the former. Now, this appears a distinct organisation —a greater amount of differentiation of parts than probably any hitherto attributed to Flagellata, though the expanding and contracting (prehensile) organ of Cienkowski's Spumella ('Schultze's Archiv für mikr. Anat.,' Bd. vi, p. 432, t. xxiv, f. 44 —49) or James-Clarke's "membranous collar"—"calyx"(' Boston Soc. of Nat. Hist.,' vol. i, pt. iii p. 305), for instance, show that Flagellata have "organs" (above and beyond the characteristic flagella). Nay, might not the capacity to project and retract this "piston-like" *organ* argue the existence of a *muscle* whereby to produce this action, still the *lined* character of this very minute organism would render the descrying of such a "muscle" a great difficulty, as certain striæ might be wrongly interpreted. Mr. Archer was decidedly of the opinion that the movement of this process in Anisonema was a true and real retraction, not an illusion due to change of position of the organism, but would be glad to have the observation confirmed when this little object should at any time hereafter present itself to the members.

Mr. Archer showed specimens of *Dimorphococcus lunatus* (Al. Braun) new to Britain, this Alga being discovered for the first

time in this country on the late excursion to Connemara. It had indeed, seemingly, as yet been found only in three sites (Rabenhorst's 'Flora Europæa Algarum Aquæ dulcis et submarinæ,' p. 36): once by Braun himself at Freiburg, again near Berlin, and once again by Itzigsohn at Neudamm. Of this little Alga, only briefly described in a footnote by Braun, in his 'Algarum unicellularium Genera nov. et minus cogn.' (p. 44), that author furnishes no figure; there is a woodcut given by Rabenhorst (*op. cit.*, p. 6, probably from sketches or specimens of Itzigsohn's?), but the figures there presented do not seem to grasp the true form or structure of the cells in what would appear to be a full-grown typical cluster or family. The upper or outermost cells do not, as they are made to seem, or as the original description might lead one to infer, stand above the larger and lower (inner) cells as upon a common stipes, but the former *grow off* from the latter, and remain joined thereto by a short pedicle (to convey some idea one might say, to a certain extent, somewhat comparable to the way in which young fronds in *Lemna trisulca* grow off from the older ones). The inner cells are broadly reniform, and two stand opposite each other at the apex of the supporting stipes, so as to present a "lunate" figure, and from the lower part of the *sinus* made by these it is that the pedicle of each of the pair of secondary more or less reniform, but unequally lobed, cells (one from each lower cell) starts, the smaller lobes of these latter *overlapping* each other, and appearing, in a crowded cluster, *like* one cell, only of smaller dimensions, concentrically posed above the lower cell, and *as if* on a common stipes, that is, as if *all* were "in ramulis . . . . quaternatim conjunctæ." The larger lower cells are combined, *inter se*, by a soft, irregular, colourless, furcated (mostly as if "*shrivelled*") stalk, into a crowded colony or family. This branched cluster of cells requires to be broken up and pressed out ere the arrangement referred to can be seen. The structure and mode of arrangement of the cells (which, it may be mentioned, are bright green, with a pale, narrow little space at upper extremity, and with large chlorophyll-granules) becomes thus of somewhat complex appearance, but without a figure it would not be practicable, in Minutes like these, to convey a correct idea of this seemingly rather marked little plant. Nor does, indeed, this arrangement of the cells, although there could seemingly be no doubt of the identification, appear, one might venture to think, to have been fully made out, even by Braun himself, for his description (*loc. cit.*) does not *seem* to convey the points which Mr. Archer tried to direct attention to in the examples now under the microscope for exhibition.

21st December, 1871.

Rev. E. O'Meara exhibited the doubtfully distinct diatomaceous form *Pleurosigma pulchrum* (Grunow), also an undescribed form of the same genus, provisionally named *Pl. mirabile*, from Bantry Bay, found in collection thence obtained by Mr. More.

Dr. Macalister showed the hairs of *Elatheura marginata*, also a portion of the tip of the ear of *Megaderma lyra*, composed of pure yellow elastic fibrous tissue.

Dr. Frazer showed some examples of *Uredo graminis*, from a field in Co. Kildare, which had become so covered with this fungus that it presented quite a yellow appearance, from the excessive abundance of the spores; settling on some clothes placed out to dry, these became so stained as to require rewashing as the only means to get rid of the discoloration.

Dr. Richardson exhibited a slide containing several specimens of striated muscular fibre, which had been passed with the urine by a gentleman in whom a communication had formed between the large intestine and the bladder. At first, the urine was not discoloured, so that the finding of them was a striking demonstration of the value of the use of the microscope in clinical medicine, for it had enabled him to give a positive opinion of the ultimate result of the case, which ended fatally in about ten days after the communication had formed; the accuracy of the opinion was verified by a post-mortem examination.

Rev. M. H. Close drew attention to some dendritic forms occurring in a layer of diamond cement between two slips of glass, the wonderful elegance of the disposition and figure of the branchings causing it to become a singularly pretty object.

Mr. Archer once more offered to the Club's attention some additional Desmidieæ, a few of them new, from the late Galway gatherings, and he presented likewise one or two further drawings. Amongst these was a very fine and very large form, with sub-elliptic, turgid, smooth segments, showing in front view two closely posed hyaline, stout, tapering, sub-acute spines at each opposite lateral extremity, these slightly directed upwards, which he felt it safer, at least for the present, to refer to *Didymocladon longispinum* (Bailey, "Micros. Observ. in S. Carolina, Georgia, and Florida," 'Smiths. Contrib.,' vol. ii, fig. 7), for though that author's figures are but coarse and descriptions nearly *nil* (as in the case of *Docidium nodosum*, Bailey, lately shown to the Club), it were better to let this stand, at least *ad interim*, as *our* Irish *Staurastrum longispinum*, for, admitting the identification as regards the present form does not involve the acceptance of the genus Didymocladon, Ralfs. In fact, that genus cannot stand, at least it is unnecessary; just as well might there be instituted a distinct genus for such forms of Staurastrum with a *pair* of elongate processes *at each angle*, when these originate on the same horizontal plane (as in *Staurastrum læve*, Ralfs, *St. bifidum* Ehr.), as maintain a distinct genus for those forms also with a pair of processes at each angle, of which one, however, is posed vertically above the other. But the present fine form offers a marked example of a characteristic, in which it, however, is by no means unique, either amongst certain forms appertaining by external figure under this genus or under some other genera of Desmidieæ, and that is the chlorophyll-contents being arranged in conspicuous parietal bands,

not in the manner characteristic of the genus Staurastrum at large, that is, forming vertical plates radiating from a central axis. Mr. Archer had ere now drawn the Club's attention to the fact that the chlorophyll-contents in *St. tumidum*, for instance, are deposited in rather broad, irregularly margined bands upon the interior of the cell-wall, that the same holds good in the species of Xanthidium, but the "bands" are there fewer and broader, forming, in fact, in each segment, four parietal "quarters" (rather than "bands"), these interrupted or separated by as many narrow, nearly straight vacancies, running down the centre of each front and each lateral aspect of the segment. This is a character of Xanthidium, apparently not generally recognised, and would seem to tend still further to cast a doubt on the validity of Pleurotænium *as a genus*. In his fine work on the Conjugatæ ('Untersuchungen über die Familie der Conjugaten,' pag. 72), Professor de Bary, in referring to Xanthidium, speaks of the chlorophyll-contents as *radiate* ("strahlig"), but as "not yet more exactly known;" however, this is an error, for the chlorophyll-layers really line the interior of the cell-wall. Now, the presence of the conspicuous chamber or cavity, with "dancing" granules close to each end of certain forms, referred by authors to the genus Pleurotænium (Näg.), would actually seem to be the only *internal* characteristic that might be considered as wanting to make such forms as those alluded to here fall under that genus, whilst, indeed, in some forms referred by authors thereto, this character is absent; nor, indeed, does it form one of those entering into Nägeli's diagnosis of his *genus*. In other words, certain species (e. g. *Staurastrum longispinum*, Bail., *St. tumidum*, Bréb., *Cosmarium turgidum*, Bréb., *Cos. de Baryi* (de By.), Arch., *Xanthidium armatum*, Bréb., *X. fasciculatum*, Ehr., &c.), if we confine our attention to their internal characters, offer the main feature claimed by Nägeli for his genus Pleurotænium ('Gattungen einzelliger Algen,' pag. 104), but if we, on the other hand, have regard to their external characters, these heterogeneous forms naturally relegate themselves to several different and well distinguished genera; nay, as Mr. Archer had ere now drawn attention to, not all the species referable by external figure to Docidium (Bréb.) agree in the parietal chlorophyll-bands. What, then, can we do with such a form as *Staurastrum longispinum* (Bail.), now exhibited, but leave it still a Staurastrum? Nor are we, seemingly, as Mr. Archer previously ventured to suggest, as yet *ripe* enough for the genus Pleurotænium. Perhaps the identification of the present form with Bailey's figure (now exhibited to the Club) may be thought to be somewhat shaken, by his neither showing any delineation whatever of a similar arrangement of the contents, nor making any allusion or throwing out any clue thereto in the text. Still, Mr. Archer thought he could trace just a faint appearance in Bailey's figures of the "bands" being indicated by the rough shading there to be seen, which may indeed, perhaps, be just as much accidental as intended. The form now shown to

the Club in Mr. Archer's drawing would seem much to resemble a new species lately described by Wittrock—*Staurastrum bidentatum* (Wittr., in 'Anteckningar om Skandinaviens Desmidiacéer,' for a copy of which highly interesting memoir Mr. Archer had very much to thank the author, whose figure he referred to), but that is a considerably smaller form, the spines at the angles reduced to two short, rounded, blunt processes; but above all the endochrome is depicted as forming vertical chlorophyll-plates radiating from the centre, thus distinctly separating the two forms; for it is quite clear that whatever may be its bearing in a *generic* point of view, the character in question abundantly distinguishes *species*, though one can, as yet, hardly think that the natural diversity thus evinced has more than a *specific* significance as regards certain forms naturally congeneric with certain others, so far as relates to their outward configuration, but these latter presenting a different internal arrangement of contents. The species really most nearly allied to the present is *St. tumidum* (Bréb.), as they resemble each other a good deal in general outline and in possessing a very thickened conspicuous mucous envelope, but the present is a somewhat smaller form, the lateral margins in the end view concave at the middle (instead of convex), and, as has been mentioned, provided with *two* elongate, closely posed spines at each angle, one only of which is conspicuous in the end view (not with a single nipple-like tubercle). They agree in the punctate character of the cell-wall, best seen when evacuated of contents, though readily enough perceptible in the ordinary condition, especially at the vacant intervals between the chlorophyll-bands.

Mr. Archer presented a drawing of another fine form referable to Staurastrum—if, indeed, the genus Didymocladon were to be considered admissible it would fall under it. This is a very elegant form, its beauty, however, somewhat interfered with by the thick and very *striated* mucous envelope by which it is surrounded, not attempted to be delineated in the drawing. It is large, constriction forming a wide, acute-angled sinus, the processes long, slender, divergent, lower ones horizontal, upper directed upward (each tier being on the *same plane*, all lateral, none dorsal), and with three or four shallow marginal denticulations, apices 3- or 4-fid, in end view 5-radiate, angles produced. It will thus be seen this beautiful form to a certain extent resembles *St. (Didymocladon) furcigerum* (Bréb.), but it is considerably larger, the rays longer and shallow-denticulate (not minutely granulate), radiate in end view (not tri- or quadrangular). It might, of course, also call to mind, to some extent, *St. pseudofurcigerum* (Reinsch, in 'Algenflora des mittleren Theiles von Franken,' p. 169, t. xi, fig. 2), but in that species the processes are short, stout, minutely denticulate, apices binate, end view 3-angular. The latter form differs, too, from the present, in possessing a pair of processes above, and radiating to each side of that projected horizontally from each opposite lateral extremity.

The present may have some affinity to the so-called *Xanthidium artiscon* (Ehr.), but, on the whole, though this appeared to be a new form, Mr. Archer would defer coming to a decision respecting it until he might have an opportunity to obtain from abroad examples of one or two forms not very explicitly recorded in 'Hedwigia.'

Another fine and comparatively large Staurastrum (of which Mr. Archer showed a drawing), possessing long arms at each of the three angles, these arms curved downwards on each segment, so as nearly to touch those of the opposite segment and with a nearly semicircular arch, thus offered, when seen in a *full* front-view, a nearly circular general contour; the constriction being shallow and the segments slightly constricted above the somewhat globose base, then gradually widening upwards, caused the space enclosed at each side between the converging arms to present a broadly cordate outline; this figure, combined with the upper outer margin being elegantly, but irregularly and tolerably deeply crenulate, even on to the ultimate extremity of the arms, all taken together, rendered this form one of singular elegance. This was very rare in the gathering, and so far as he was aware was a new form, and he hoped to prepare a detailed description of this and a few others at an early date. Several other pretty things were met with in the same material. Amongst those a Cosmarium surrounded most elegantly by four series of very prominent, semi-hyaline, emarginate tubercles, and with a central group of prominent but entire tubercles, was a beautiful object (this had been obtained two years since at Glengariff), a new but minute Hyalotheca, a new Didymoprium—but to expatiate on these any further in this place without figures, and without systematically prepared descriptions, would not serve any good purpose, yet, perhaps, the lovers of the beautiful forms appertaining to this group might not take these desultory references altogether amiss.

East Kent Natural History Society.

President, the Rev. John Mitchinson, D.C.L., &c., Oxon; Honorary Secretary, George Gulliver, F.R.S., &c.

Confining, as before, these reports chiefly to observations involving microscopic work, details will be omitted of extensive business in other departments. But the whole proceedings of the Society are so extensively and accurately reported, at Canterbury, in the 'Kentish Gazette,' as to afford an excellent example of local journalism, or indeed of any journalism; and extracts therefrom appear in many of the scientific and other

periodical publications which pay but little or no attention to the microscope.

December 7th, 1871.—The meeting prevented by the snow storm.

21st.—Colonel Horsley displayed the markings of *Pleurosigma quadratum*, under a deep object-glass with the aid of Reade's prism and Webster's condensor, in order to show that the effect is the same as that produced by the simpler method of illumination which he had shown at former meetings. Mr. Down exhibited some deep telescopic eye-pieces successfully adapted to the microscope. Mr. Fullagar presented a preparation, mounted in Canada Balsam, of the egg-shell of *Locusta viridissima*, showing the trumpet-shaped microphyles admirably, Mr. Gulliver gave an account of the big shark (*Lamna cornubica*) which he had seen landed at Hastings, Nov. 10, 1871; and after some observations on the anatomy of the Selachii, and on the wanton waste of good food and oil in the myriads of smaller sharks or dog-fish contemptuously left to rot on our coasts, proceeded to a comparative view, illustrated by dried specimens, of the red Corpuscles of the Blood of Fishes. In the different orders of osseous fishes these corpuscles do not vary much in size and form, though some are of a much longer oval figure than others; and sometimes they are oat-shaped, crescentic, or even triangular or polygonal, all shapes that may be well seen in the Gadidæ, and that might occur from alterations in the regularly oval or sub-oval discs, among which are often seen some of circular figure. In the Cartilaginous Fishes, as is well-known, the blood-discs are much larger; but they seldom present such changes of form, though perhaps those of *Myxine*, long since described by Johannes Müller, might have been misshapen. In the Lampreys, though the red corpuscles are circular, they conform both in size and structure to the red corpuscles of other Pyrenæmata; just as the red corpuscles of Camelidæ, though oval in shape, agree completely in size and structure with the red corpuscles of other Apyrenæmata. As to the blood-discs of the sharks, they are of about the same size in the great Porbeagle as in the small and common dog-fish, as noticed in the 'Quart. Journ. Mic. Science' for January, 1872. Hewson, upwards of a century since, discovered the large size of the blood-discs of Plagiostomi.

January 18th, 1872.—Mr. Bell exhibited a live *Chamæleon vulgaris*, from which some blood was then obtained and its red corpuscles examined. Their mean long diameter was found to be $\frac{1}{1391}$ and their short diameter $\frac{1}{2400}$ of an inch, measurements which correspond nearly with those of the blood-discs of other scaly reptiles. Mr. Gulliver dissected a fresh Smelt (*Osmerus eperlanus*), in order to illustrate a lecture which he gave on the structure of this and the other members of the Salmonidæ. Of the Maxillary Teeth, characteristic of the family, he showed how they were often not represented, even by our best artists, in many of the otherwise excellent paintings and engravings of these

fish, a defect which was painful to the eye of the ichthyologist; and that art should, in this as in other cases, take a lesson from nature. The so-called Adipose Fin, commonly described as "without any rays whatever," was shown, under an object-glass of half-an-inch focal length, to be quite devoid of any fat, and provided with a multitude of very thin rays, some of which occasionally project beyond the free margin of the fin. But these rays, being homogeneous, transparent, and structureless, like the fibres of the crystalline lens, and unprovided with muscle for their movements, are not quite identical with the true rays of the locomotive fins. The Fibres of the Crystalline Lens were shown to afford a good example of the sinuous and interlocking edges; and these being compared with those of other fishes, were proved to afford excellent taxonomic characters between different members of the class. Thus, *e. g.* the lens-fibres of the Lampreys are smooth at the edges; of the common Eel but little indented; of the Conger more so; and, of the majority of the class, so very much and deeply notched, as to produce the well-known interlocking or dove-tailing of the margins of the fibres, as is well seen in the salmon-family. Nor is the difference of the diameter of the fibres less remarkable in different orders of the class. The facts were illustrated by preparations, and extemporaneous dissections, under the deep glasses of Colonel Horsley's, Mr. Sydney Harvey's, and Mr. Bell's microscopes, thus showing how easily the objects may be displayed, even by the most inexperienced micrographers, and what really beautiful preparations may be made of these fibres from the lenses of different fishes, ever ready at the shops as well as in the great field of nature. In fact, this kind of microscopic inquiry is at once so useful and delightful, both in the animal and vegetable kingdoms, that it seems amazing that one or other of our great Microscopical Societies has not yet given precise directions concerning the various branches thereof, for the guidance of those numberless microscopists who are now wasting their energies in advertisements and anxious searches for "good stuff for the microscope." But the worthy veteran Dr. Lankester had taken a right step in this direction, by pointing out what profitable objects the cell-structure of plants might thus afford. And now we have seen how even such a single part as the eye-lens of animals might be easily made into numberless microscopic objects, very beautiful individually and not less useful collectively in the service of systematic zoology.

30th.—The General Annual Meeting was held; and the Report, containing the Address of the President, the report of the Committee, the Proceedings of the Society, and other matters, has since been issued to the members. There was afterwards a recess of several weeks.

March 7th.—Colonel Horsley gave some explanatory sketches of his views concerning his method of resolving the markings of Pleurosigma. Mr. Fullagar produced very small and lively

Polyps, bred in his aquarium, as he believed, from autumnal or winter eggs of *Hydra vulgaris*; he showed also neat preparations of the lingual teeth of Planorbis; whereupon the Hon. Secretary detailed some of his own experiments showing, as he believed must be already known, that these teeth in snails and slugs are composed of pure silex, and so no wonder that these creatures should be able to comminute or bore through very refractory substances. Mr. George Gulliver, late of the King's School, exhibited living specimens of *Argas reflexus*, and read a paper thereon, of which the following is a summary:

On a Canterbury Arachnid new to the British Fauna.

Although a great fane in the midst of a populous city might seem an unpromising field for an exploratory excursion of a Natural History Society, we shall soon see that our venerable cathedral harbours a zoological species not yet discovered elsewhere in Britain. This animal is the *Argas reflexus* of Latreille, *Rhynchoprion columbæ* of Hermann, and *Ixodes marginatus* of Fabricius. It is about a third of an inch long and a fifth broad, but many are smaller, and some not more than a fifteenth of an inch in length. They are all opaque, of a dark, dull, and uniform brown color, and with a well-defined entire and paler margin. The coriaceous integument of the under and upper parts of the larger specimens is regularly dotted, and these dots under the microscope recall the shagreen of certain Selachii, and appear to be composed of carbonate of lime; at least they dissolve quickly and completely, with evolution of gas, when treated with an acid. Each foot has at its tip two very sharp sickle-shaped claws, by which the creature holds on to its host; and there is also a tubercle at a little distance from the base of the claws. Though like a tick, no such proboscis as that which distinguishes the true ticks was seen, nor could any eyes be discovered. When punctured, much fluid of a very dark red colour exuded, and this colour was found to be owing to numerous oblong corpuscles, very variable in size, but those of average magnitude were each about $\frac{1}{183}$ of an inch long and $\frac{1}{444}$ broad. They were individually of an intensely deep red colour, and all readily soluble in weak acetic acid, though they retained their form distinctly for many days in water, being not at all soluble therein. On dissection the seat of these curious red bodies seemed to be within the alimentary cæca. There were also many minute molecules in the fluid. This remarkable Arachnid has long been known in the dark recesses of our time-honoured fane, and regarded there as an "Insect peculiar to Canterbury Cathedral." The verger, who gave some of them to Mr. Fullagar, so described them; and of these my father kept a few quite without food, in a tin box, for upwards of five months, during the whole of which time they continued lively, and ever ready, when touched, to sham death, after the manner of veritable spiders. As we could not identify the Cathedral arachnid

with any specific description, and were told by some of the most eminent British entomologists that our specimens were nothing but starved sheep-ticks, I took one of them up to Oxford at the beginning of last term, when the illustrious entomologist, Prof. Westwood, declared, and was the first to determine, it to be the *Argas reflexus*, a parasite infesting pigeons, and known on the Continent, but heretofore not recognised in Britain. So our arachnids had probably dropped from these birds, and are certainly to be found rather plentifully crawling about the inside of the base of the cathedral.

Literary and Philosophical Society of Manchester.

Microscopical and Natural History Section.

February 5th, 1872.

Joseph Baxendell, F.R.A.S., President of the Section, in the chair.

Mr. Joseph Sidebotham, F.R.A.S., called the attention of members to the origin and spread of typhoid fever, as connected with the germ theory.

February 26th, 1872.

Joseph Baxendell, F.R.A.S., in the chair.

Mr. Mark Stirrup exhibited sections of shells of mollusca, showing so-called fungoid growths. He referred to Dr. Carpenter's report on shell structure, presented to the meeting of the British Association, in 1844, in which especial mention is made of a tubular structure in certain shells, and he cites the *Anomia* as a characteristic example. In the last edition of 'The Microscope,' Dr. Carpenter withdraws his former explanation of this structure, and now refers it to the parasitic action of a fungus. Mr. Stirrup showed sections of this shell penetrated by tubuli from the outer to the inner layers of the shell, and it is upon the inner layer that the curious appearance of sporangia, with slightly branched filamentous processes proceeding from them present themselves.

The parasitic view is strengthened by the fact that these markings are not found on all parts of the shell, and are certainly accidental.

Professor Kölliker maintains the fungoid nature of these tubuli in shells as well as in other hard tissues of animals, as fish scales, &c.

Wedl, another investigator, considers the tubuli in *all* bivalves to be produced by vegetable parasites, and that no other interpretation can be given.

This view does not seem to be borne out by the section of another shell which was exhibited, *Arca navicula*, in which the tubuli are always present, forming an integral part; they are disposed in a straight and tolerably regular manner between the ridges of the shell; moreover, they have neither the irregularly branched structure nor the sporangia.

Silesian Society for National Culture.

Section of Natural Science.

Bacteria and their relations to Putrefaction and to Contagia.—Professor Cohn delivered a lecture on this subject at the meeting of February 14th. Denoting by *fermentation* the decomposition of certain non-nitrogenous substances excited by microscopic organisms, he described the analogous decompositions of nitrogenous, and especially albuminous substances, as *putrefaction*. While the phenomena of fermentation have been most elaborately and fruitfully studied of late years by Pasteur, the process of putrefaction has been till now neglected by investigators, and especially by chemists. Cohn's own investigations have given the following results:—1. All putrefaction is accompanied by the development of bacteria; it is wanting, if the access of these is prevented; it commences as soon as bacteria are present, even in the smallest number; it proceeds in the same ratio as these smallest of all organisms multiply; and with the completion of putrefaction ceases also the multiplication of the bacteria, which are then precipitated as a powder, or else in gelatinous lumps (Zooglea), just as yeast precipitates in completely fermented sugar solutions.

There can be accordingly no doubt that bacteria are essential factors in putrefaction just in the same way as yeast fungi have been proved to be in fermentation. Moreover, the bacteria are the only organisms which appear exclusively during putrefaction, and under all circumstances, and when the access of alien germs prevented; they are therefore excitors of putrefaction (*saprogenous* bodies) while the other organisms developed in putrefying substances, the mould fungi and infusoria, are only to be regarded as accompaniments of putrefaction (*saprophilous* bodies). There is no genetic relation between bacteria and mould fungi as often supposed.

2. The question, how the bacteria which excite putrefaction find their way into nitrogenous substances is generally answered by supposing that their germs come from the air with the dust. But this hypothesis, supported alike by the experiments

of Appert, Schwann, Schröder, Dusch, Pasteur, and Tyndall, appears to be contradicted by the very noteworthy investigations of Burdon Sanderson, lately published in his 'Second Report of Researches concerning the intimate Pathology of Contagion.' According to these researches the germs of fungi do come to putrescible substances from the air, but not the germs of bacteria. Infection with bacteria is effected solely by contact with dirty surfaces (skin, instruments, or vessels), but especially by means of water, which always, even when freshly distilled, contains bacteria germs. Even saliva, urea, blood, pus, milk, egg albumen, may become mouldy, but do not putrefy when exposed to the air, if they are at the same time protected from contact with water containing bacteria, or surfaces of the same kind.

Cohn's researches have, indeed, only partially confirmed these statements, but still chemical solutions exposed to the air were, as Sanderson has shown, as a rule protected from putrefaction, but not from mould. The convection through the air of bacteria germs (the volatilization of which Cohn has directly demonstrated) does at all events take place with difficulty,—presumably because the air is not sufficiently loaded with bacteria,—while infection with water instantaneously causes putrefaction to begin.

3. The nutrition of bacteria at the expense of the putrefying albuminous substances is generally conceived of as if the bacteria obtained the nitrogenous contents of their cells (protoplasma) immediately from these substances. This view is, however, incorrect.

While all animals do in reality form their nitrogenous tissues out of the albuminous substances which they receive ready formed with their food, bacteria, and presumably all fungi, agree with the green plants in assimilating the nitrogen of their protoplasma in the form of ammonia or nitric acid. Bacteria, however, and fungi in general, are on the other hand distinguished from the green plants by absorbing the carbon which is a constituent of their cells, not from carbonic acid, but from other more easily decomposed carbon compounds, especially from carbohydrates. Pasteur had previously found that yeast fungi go through their normal development in a fluid containing ten parts crystallized sugar candy, and one part of ammonium tartrate in 100 parts of distilled water, and Sanderson showed that Pasteur's fluid is also a suitable nutritive medium for bacteria. The result of Cohn's researches is to prove that sugar is not necessary for bacteria; they develop and multiply in a perfectly normal manner in any fluid which contains, beside ammonia or nitric acid, a non-nitrogenous carbonaceous body. If a drop of fluid containing bacteria be added to a one per cent. solution of ammonium tartrate, the fluid remains clear for three days, and then if maintained at a temperature of 30°, becomes turbid and gradually milky, while thick bacterium mucus accumulates on the surface, till after some weeks the fluid becomes clear again and deposits an abundant precipitate of bacteria. Almost the same thing is observed with solutions of ammonium succinate, potassium tartrate

with ammonium nitrate, glycerin and potassium nitrate, potassium tartrate and potassium nitrate, &c. On the other hand, bacteria do not multiply in ammonium nitrate, potassium tartrate, or solution of urea, but they do in the latter if potassium tartrate be added. As will be taken for granted after the researches of Pasteur, it was necessary in all these experiments to add to the solution a certain quantity of phosphoric acid, sulphuric acid, potash, lime and magnesia.

4. Since bacteria assimilate nitrogen in the form of ammonia or nitric acid, their work in putrefaction can only be conceived of in the following way:—That they split up the albuminous compounds into ammonia which is assimilated, and into other bodies which appear as by-products of putrefaction; and the nature of the latter is as yet only imperfectly known, though it will certainly be elucidated by the study of the putrefaction of chemical solutions (3). Perhaps it is by means of the ammonia thus set free that the bacteria make insoluble albuminous compounds soluble in putrefaction. Putrefaction is then splitting up of albuminous compounds by bacteria, just as alcoholic fermentation is splitting up of sugar by the yeast fungus.

5. With a certain class of bacteria the products of decomposition are characterised by being coloured. This "pigment-rot" has been previously observed, especially on the surface of boiled potatoes, bread, meat, &c., where purple red gelatinous masses (*Monas prodigiosa*) are produced. Yellow and blue pigments have been observed in milk, green in pus, in other cases orange, yellow, brown, and violet pigments. The producers of "pigment-rot" are not the ordinary rod-like or cylindrical bacteria (*bacterium termo*), but spherical bodies, arranged in pairs, or in beaded chains, or imbedded in mucus, which have no independent movements, and are distinguished as spherical bacteria or *bacteridia*.

Cohn has also succeeded in producing "pigment-rot" in chemical solutions. Solutions of ammonium acetate and potassium tartrate become coloured in a few days, after the addition of a drop of fluid containing bacteria, first greenish, then bluish-green, finally a beautiful blue, like copper sulphate, while there was continually increase of turbidity, caused by cylindrical and spherical bacteria, which at length caused the previously acid reaction to become alkaline. The blue colouring matter is turned red by acids and blue again by ammonia, and appears to be identical with litmus, which is well known to be also produced by the pigmental putrefaction of colourless extracts of lichens in presence of ammonia.

6. The presence of bacteria in the blood, or in various secretions, has been lately demonstrated in a number of contagious diseases; it is in a high degree probable that these corpuscles are the vehicles of infection and the excitors of morbid processes. Presumably they cause, when introduced into the vessels, a decomposition of the blood, and thus generate by-products, which even in infinitesimal quantity cause disturbance of the normal vital processes. Cohn testifies that all the organisms yet demonstrated in contagious

diseases, such as "the blood" in sheep, small-pox, vaccine-pox, puerperal fever, silkworm diseases, &c., do not belong to the moving cylindrical bacteria of putrefaction, but to the motionless, often beaded spherical bacteria. With respect to the propagation of contagion Cohn points out the great importance of drinking water, and has detected in waters which have been suspected to convey disease, a high degree of putrescibility, or even already existing putrescence, which is also shown by the large amount of albuminous or even ammoniacal compounds.

MEMOIRS.

REMARKS *on the* STRUCTURE *of the* GREGARINÆ. By Professor EDWARD VAN BENEDEN. (With Plate XI.)

IN a work published in the 'Bulletins of the Royal Academy of Belgium' (vol. xxxi, No. 5, 1871), and 'Quart. Journ. Micro. Science' (vol. xi, new ser.), I have made known the successive conditions of the evolution of a new Gregarin found in the intestines of the lobster, and described on a former occasion under the name of *Gregarina gigantea* ('Report of the Royal Academy of Belgium,' vol. xxix, No. 11, 1869, and 'Quar. Journ. Micro. Science,' vol. ix, new ser.). I have established through my investigations that the psorosperms give birth to small protoplasmic globes, which differ from Amœbæ in that they are devoid of all cell-nucleus, and in that they never show any trace of vacuole. They represent, from a morphologic point of view, the Monera of Haeckel, and the Gregarinæ pass, during the course of their autogenic evolution, through the Monerian condition. At that time they are simple gymnocytods, and only become cells when a nucleus develops itself in their interior. On the surface of each cytod grow two protoplasmic prolongations. Simple buds in their beginning, these prolongations stretch out, absorbing at the same time the body of the cytod, and when they become free they move in the intestines of the lobster, like little nematod worms. From thence the name of Pseudofilaria, which I have given them. Not long after, they become shorter, and at the same time their movements become less active; they soon cease altogether; a voluminous nucleolus then appears inside the body, this at once becoming surrounded by a nuclear coating. From this time the cytod has become a cell; the separation of the chemical elements of the nucleolus and of the nucleus from the essential elements of the body of the cell has led to the differentiation of the original matter, which I have called "plasson," into three distinct layers—the nucleolus, the nucleus, and the protoplasma.[1]

[1] The beautiful observations that Eimer has recently published on the

The cell has only now to grow to become the beautiful Gregarine, of the $\frac{10}{1000}$th part of a mètre long, to which the lobster complaisantly gives home and nourishment; but at the time of its growth the cell undergoes in its protoplasmic body new phenomena of differentiation, and the complication which then appears in the cell-body allows one to affirm that certain monocellular organisms can present a real organization, and that they are composed of parts which must be distinguished, as much from a morphological point of view as from a physiological one. Before describing this complication of structure, and in particular those elements that constitute inside a monocellular being a real muscular system, I have thought it necessary to recall, in a few words, the results of my investigations on the evolution of the Gregarinæ, because they show that the Gregarina is but one single cell, and that it represents to us, without any doubt, a monocellular individuality.

The giant Gregarina's body is of a cylindroid shape; its diameter varies little, at the most a small progressive narrowing in its terminal parts, and a slight dilatation, the development of which is variable, near its anterior extremity. A cellular membrane, which I call cuticle by analogy with with the cuticle of Infusoria, limits the body externally, and the Gregarina is really only a long cylindrical sac, closed at each of its ends. This membrane shows no trace of mouth nor orifice, nor are any canalicular pores distinguishable; it appears perfectly homogeneous, and the nutritive liquids can only penetrate by endosmosis. The membrane is of the same thickness in every part. In individuals which have reached their complete development its limit is most exactly fixed on the inside as well as on the outside, and shows a strongly marked double contour. But this is not the same in young individuals; in them the cuticle is very difficult to find, because it is not completely isolated from the subjacent protoplasmic matter; there is an imperceptible passage between the contents of the cell and the external coating of the protoplasm, which gradually transforms itself into a cortical substance.

The contents of the cell, forming the parenchyma of the

psorosperms of higher animals confirm on all points my investigations on the evolution of the Gregarinæ of the lobster. The phases of psorosperms (figs. 53, 54, 56, and following in his work), of semilunar bodies, swelling at one end (fig. 34), of scythe-shaped bodies (fig. 36, and following), of semi-ovoid cells (fig. 47), and of nucleated Gregarinæ, correspond to the conditions which I have designated under the name of Monerian condition, of generative cytod, of pseudo-filarium, of young Gregarinæ, and of complete Gregarinæ.

body, may be divided, just as in the Infusoria, into "*a central column, or medullary parenchyma, a peripheric coating or cortical parenchyma, and a very thin subcuticular coating, which constitutes the muscular coating.*"

The medullary parenchyma appears in the greater part of the length of the cell, under the appearance of a dark band, occupying the axis of the body. It is composed of a very granular substance, and much more fluid than the cortical substance. The grains it contains are rather voluminous, and very refracting; they are seen to change their places, and move under the influence of the contractions of the Gregarinæ. The middle parenchyma really constitutes a massive column, which completely fills the hollow cylinder, circumscribed by the cortical parenchyma. The nucleus of the cell, of which the form is usually ellipsoidal, occupies the entire breadth of the cylinder. If the body of a Gregarine still alive is cut transversely, either above or below the nucleus, the central fluid matter runs off in a columnar shape, without carrying away the nucleus with it; and since the cortical matter remains in its place, there develops inside the body a cavity, circumscribed on the outside by the cortical parenchyma, at the top by the nucleus, at the cut end by the exuding medullary column (fig. 6). When the medullary matter spreads, it dilates, the granules separate one from another, and continue diverging, each animated by very intense Brownian movements, each oscillating by itself.

The cortical layer (Leidy's muscular layer) is composed of a slimy protoplasmic matter, much less fluid, much less granular, and, therefore, clearer than the medullary substance. The granules of the cortical parenchyma are not only less numerous, but much more slender and refracting, than those of the central column. Just as in Infusoria, there is to be found no strong line of demarcation between the two layers; there is an imperceptible passage from one to the other. Near the posterior extremity of the body these two substances are with difficulty distinguished. The surface of contact between the medullary parenchyma and the cortical parenchyma is not always a simple cylindroid surface; the medullary coat presents sometimes on the external surface channelings approximated more or less one to the other, into which the cortical substance moulds itself. The ridges of the medullary column, and the corresponding sides of the cortical substance, are more or less numerous, and more or less near to each other. As they are always parallel to the axis of the cylindrical body of the Gregarine, they communicate to it a longitudinal striation, the sides of the cortical

column producing the effect of lighter longitudinal striations. The channelings and the longitudinal striations that are their consequence appear and disappear, and it is impossible for one to tell the signification of this arrangement.

Many naturalists have described the longitudinal striation of the body of certain Gregarinæ. Lieberkühn[1] recognised such a striation at the posterior extremity of the body of Gregarinæ that are found in the testicles of Lumbrici ('Monocystis et Zygocystis' of Stein). Just as Claparède,[2] who observed a double system of striations on the surface of the body of a Gregarina, from a Phyllodoce, so Lieberkühn has neither inquired the cause nor the signification of these striations. Leidy[3] first described a layer distinctly characterised by longitudinal striation, and called it the muscular coating (it corresponds to our cortical coating). Leuckart[4] confirms the observations of Leidy, but he emits the opinion that the striation depends on the momentary folding of the subcuticular cortical membrane. This perfectly correct interpretation has been recently adopted by Ray Lankester.[5] According to him, also, the longitudinal striations are only the result of a state of momentary contraction of the would-be muscular tunic of Leidy. When I published my first work on the Gregarinæ of the lobster, I then also recognised the true value of the longitudinal striations, attributing them, not to an organic permanent disposition, but to a passing state of the cortical tunic of Leidy.[6] Nothing, however, proves the muscular nature of this coating; the longitudinal striations are not muscular longitudinal fibrils, but the result of a thickening, following a longitudinal direction, of the cortical substance. This is probably susceptible of local contractions; it is likely that it allows the Gregarine to roughly bend, in elbow form, and also determines the movements of translation of the granules of the medullary fluid layer; but it consists only of protoplasm, not transformed into muscular substance.

A third very thin coating, which has completely escaped the observation of naturalists who have studied Gregarinæ,

[1] Lieberkühn, 'Evolutions of the Gregarines,' p. 24, pl. i, fig. 1.

[2] Claparède, 'Anatomical Investigations among the Hebrides,' p. 43, pl. v.

[3] 'Transactions Amer. Phil. Soc. at Philadelphia,' 1855, vol. x.

[4] Leuckart, 'Bericht über die Leistungen in der Naturgeschichte der niederen Thiere wahrend der Jahre,' 1841—1853, p. 108.

[5] Ray Lankester, 'Transactions Micro. Soc.,' 1, VI, pp. 23-28, Tab. V.

[6] Edouard van Beneden, "Sur une nouvelle espèce de Gregarines designée sous de nom de Gregarines," 'Bull. de l'Acad. Roy. de Belg.,' 2 série, t. xxviii, p. 447. 'Quart. Journ. Micro. Science,' vol. ix, new ser.

is found between the cuticle and the cortical parenchyma. It is about as thick as the cuticle; it enlarges slightly at the anterior extremity of the body, and it is this that is inflected to constitute the transverse partition which separates the anterior from the posterior chamber. This layer is developed on the whole surface of the posterior chamber; but it stops a little in front of the partition of separation between the two chambers, so that the cephalic chamber is only covered on its posterior face, and on a small part of its lateral face by the layer of which we are speaking.

It consists of a colourless substance, homogeneous and transparent, formed by transverse fibrils, composed of a very refracting substance; these present all the appearance of the muscular fibrils of Infusoria. These fibrils form either circular rings or a continual spiral developed on the whole surface of the Gregarina; but they are wanting in the transverse partition, which is exclusively composed of a transparent colourless substance.

If we examine the *surface* of the body of a Gregarina with a high power (obj. 9 or 10 immersion of Hartnack) in the intestinal liquid of the lobster, or in the serum of its blood, we distinguish a transverse striation (very evident) in the sub-cuticular layer (fig. 1). These dark striations are very near each other; they are placed with perfect regularity always equidistant, and they are nearly as evident as the transverse striation of the muscular fibres of an Arthropod or a Vertebrate. They become still more distinct under the influence of acetic acid, chlorhydric acid, or a weak solution of osmic acid.

These striations are not the result of a momentary plication of the sub-cuticular membrane; *they depend on real preformed organs*, on transverse fibrils, situated in the sub-cuticular layer; for if, instead of placing the microscope so as to observe the surface of the Gregarina, it is placed so as to observe its optical section, one distinguishes very clearly on the edges immediately under the cuticle refracting corpuscles of circular shape, situated at equal distances from each other, the diameter of which is just the same as that of the transparent layer in which they are found (fig. 2). By changing progressively the focus of the microscope, it is seen that these corpuscles are only really optical sections of the small transverse bands seen on the surface, and that consequently *these striations are produced by real transverse circular fibrils*. These fibrils, composed of a very refracting substance, alternate with light clear striations, formed by the fundamental substance of the muscular layer. The

clear substance must be considered as forming the foundation of this muscular layer, since where it thickens near the anterior extremity of the body, on a level with the transverse partition, the fibres no longer occupy the entire thickness of the layer; there the transverse fibrils are really held in suspension in the transparent substance, which in itself alone constitutes the entire partition. The fibrils are not always found, at this level, near the cuticle (figs. 2 and 3); sometimes the first fibrils envelope like so many rings the posterior part of the anterior chamber (fig. 1).

If, after having in some places torn the cuticle, the body of the Gregarine is slightly compressed, the contents flow away, carrying here and there the muscular coating with the fibrils it contains. These are then seen isolated, and it can be perfectly recognised that these fibrils are composed of small refracting corpuscles, elongated transversely, and very close to each other (fig. 5). After having by this proceeding recognised the structure of the fibrils, I was able to see the constituent corpuscles of these elements, in the living Gregarine. For that, it is only necessary to slightly compress it, and to examine the fibrils on a level with the nucleus of the cell with a high power. At this point the granular matter of the medullary column is replaced by a homogeneous and transparent nucleus, and it is far easier, aided by this greater transparency, to distinguish the details on the surface.

If it were still possible to admit Dr. Bowman's ideas on the structure of the striated muscular fibres of higher animals,[1] I would believe it possible to compare the muscular coating of the Gregarina to a muscular fibre in its developing stage, whilst it still shows in its central part protoplasm not modified, and whilst the peripheric part alone has been transformed into a muscular substance. For at this time the transverse discs formed by the juxtaposition of sarcous elements are only simple rings, which may be compared to a circular fibre of the Gregarinæ. The clear and little refracting fundamental substance of the muscular coating of the Gregarina might be compared to the clear and monorefracting layer of substance, separating, in a striated muscular fibre, the discs formed by "*sarcous elements.*"

We should suppose, in fact, that in a single cell the peripheric coating of the protoplasm can become transformed into muscular substance, as well as in a nucleated protoplasmic mass,

[1] Bowman, 'On the Minute Structure and Movements of Voluntary Muscles,' London, 1840.

really formed by the fusion of a certain number of cells. But the last works of Krause,[1] Hensen,[2] Flögel,[3] and Merkel,[4] on the structure of striated muscular fibre have so much modified our ideas on the organization of these elements, they have shown to us so complicated a structure in these fibrils, that all assimilation of the muscular fibres of the Arthroprod and the Vertebrata to the muscular mechanism of the Gregarine, appears to me now impossible. It is only by comparing the muscular fibrils of the Gregarina with the fibres of Infusoria that the meaning which I have given to these elements appears to me justifiable.

To finish the description of the Gregarina it is necessary to say something more as to the contents of the anterior or cephalic chamber. These contents are always very granular and very opaque, at least in the central part of the chamber. The refracting granules that this part of the body contains are remarkable for their pretty considerable size, and by the ease with which, under the influence of an increasing pressure, they fuse one into another, and form thus irregular piles of a highly refracting substance.

When the Gregarina reaches its complete development, notwithstanding its monocellular nature, it appears to us then to be a being with a rather complex structure. As in pluricellular organization, the division of physiologic work brings about the differentiation of the cells and the progressive complication of the organization, so, in the same way, this principle of the division of work brings about in certain monocellular beings a local differentiation of the protoplasm, and causes the formation of distinct organs.

In the Gregarine such are the cuticle, the muscular layer, the cortical substance, the medullary column, the transverse partition, and the cephalic chamber. All these parts are but the result of the slow transformation of the protoplasmic body of the young Gregarina; progressively the different layers show themselves during the course of the autogenic evolution; it is also at a relatively advanced epoch of development that a transparent partition appears between the anterior extremity of the body, characterised from the beginning by an accumulation of refracting globules, and the posterior chamber. All these modifications are produced

[1] Krause, 'Zeitschrift für Rationnelle Medizin,' iii Beitsc., 33 Bd., p. 265.
[2] Hensen, 'Arbeiten des Kieler Physiol. Institut,' 1868, p. 1.
[3] Flögel, 'Archiv für Microsk. Anat.,' Bd. 8, 1 Lief.
[4] Merkel, 'Archiv fur Microsk. Anat.,' Bd. 8, 2de Lief, p. 244.

in the cell by the transformation of the protoplasm into cuticular, muscular, cortical, and medullary substance.

An important question of which, before concluding, I wish to speak, is the question of the affinity between Gregarinæ and Infusoria, or rather between Infusoria and the cell. The opinion that Infusoria should be considered as monocellular beings was generally given up the day the complex structure of these organisms became known. That complication appeared to contradict the monocellular nature, for the cell appeared to be the final expression of organic simplicity. Nevertheless it has been impossible until now that statements have been based on the anatomical study of these organisms, or that what one knows of their development, can have been taken into consideration in the attempt to show their pluricellularity.

All that we have said and made known on the structure of Gregarinæ shows, first, that, contrary to the generally received opinion, a monocellular organism can attain a high degree of complication; second, that there is a great analogy between the tunics of which our Gregarine is composed and those recognised in Infusoria. We have no reason therefore, at any rate in consequence of their rather high organization, to sustain *à priori* that microscopic animals are pluricellular beings; and it is a question if the muscular layer, the cortical parenchyma, and the medullary substance of Infusoria are not homologous with these same elements in the Gregarinæ; the solution of this question in the affirmative would demonstrate the unicellularity of Infusoria. Without wishing to maintain that these organisms are of a monocellular nature, I think we may ask ourselves the question, for our present knowledge of Infusoria has not solved it as yet. The exact knowledge of the autogenic development of these organisms could alone decide the question of the homology of their layers with those of our Gregarina, and throw light on the genealogic affinity which binds Infusoria to the most simple monocellular organisms.

On "Molecular Coalescence," *and on the* Influence Exercised *by* Colloids *upon the* Forms *of* Inorganic Matter. By W. M. Ord, M.B. Lond., M.R.C.P., Lecturer on Physiology at St. Thomas's Hospital. (With Plates XV & XVI).

Those who are acquainted with Mr. Rainey's researches will not find a great deal of new matter in the preliminary communication by Professor Harting, of Utrecht, on the "Artificial Production of some of the Principal Organic Calcareous Formations," which appeared in last quarter's number of this Journal.

But finding in Professor Harting's paper no mention of Mr. Rainey, and inferring from this circumstance that the Professor is not acquainted with Mr. Rainey's work in the field of "Synthetical Morphology," I conclude that on the continent, as at home, this work has not met with the notice and appreciation it deserves. I have thought, therefore, that a general account of Mr. Rainey's investigations, and a more particular one of later inquiries founded upon them, might interest and inform some of the readers of this Journal, and perhaps stimulate to further development the method of research by synthesis.

In the number of this Journal for January, 1858, Mr. Rainey published some of his observations, but later in the same year he put before the world a complete statement of his experiments and conclusions in the form of a book, "On the Mode of Formation of Shells of Animals, of Bone, and of several other Structures by a process of Molecular Coalescence, demonstrable by certain artificially formed products." In the preface to this book, dated October, 1858, he lays claim to originality in respect of—first, a process by which carbonate of lime can be made to assume a globular form, and the explanation of the nature of the process, "molecular coalescence," by which that form is produced; second, the explanation of the probable cause of crystallisation, and the manner in which the rectilinear form of crystals is effected; third, the discovery of a process of "molecular disintegration" of the globules of carbonate of lime, by inverting the mechanical conditions upon which their previous globular form had depended; fourth, the recognition in animal tissues of forms of earthy matter analogous to those produced artificially; and, fifth, the deduction from the above fact and considerations of the dependence of the rounded forms of

organized animal bodies on physical and not on vital agencies."

Like Professor Harting, Mr. Rainey made the globular form of carbonate of lime the starting-point in his remarkable series of demonstrations. But he did not venture to construct a name for them, and it has been reserved for the Professor to act as sponsor, and ask that they should be christened "calcospherites." Whether more good or harm be gained by this sort of scientific name-giving is no doubt a debateable question. If the name be admitted, however, it must be fully understood that insoluble calcium salts are not the only substances capable of assuming the spherical form, but that barium, magnesium, iron, copper, mercury, and, possibly, other metals, can act as bases of "spherites." Putting this aside, the much more important fact remains that Professor Harting and Mr. Rainey, as perfectly independent observers, have started severally on a new path of investigation, and have arrived at substantially the same results. As lovers of truth they may be well envied the sensations with which, on the one hand, Mr. Rainey will have seen the drawings in fig. 1 of the Professor's recent paper; and, on the other hand, the Professor will find the fourteen-year-old drawings on page 12 of Mr. Rainey's book.

The "abridged report" of the Professor's series of researches is necessarily brief as to the details of experiments. No invidious comparison, therefore, can be assumed if attention be drawn to the care and accuracy with which Mr. Rainey carried on his questionings of nature, and to the general results of these questionings.

At pages 5, 6, and 7 of the book mentioned is found a description of the method of obtaining the globular form of carbonate of lime:

"It consists in introducing into a two-ounce phial, about three inches in height, with a mouth about one inch and a quarter in width, half an ounce by measure of a solution of gum arabic saturated with carbonate of potash (the subcarbonate of the old pharmacopœias). The specific gravity of the compound solution should be 1·4068, when one ounce will weigh 672 grains. This solution must be perfectly clear; all the carbonate of lime which had been formed by the decomposition of the malate of lime contained in the gum, and also all the triple phosphate set free by the alkali, must have been allowed completely to subside. Next, two clean microscopic slides of glass, of the ordinary dimensions, are to be introduced with the upper end of one slide resting against that of the other, and with their lower ends separated

as far as the width of the phial will permit; and, lastly, the bottle is to be filled up with a solution of gum arabic in common water, of 1·0844 specific gravity, one ounce of which will weigh 520 grains. This solution must also be perfectly clear, having been first strained through cloth, and then left to stand for some days to allow of the subsidence of all the floating vegetable matter. It must also be added carefully to the alkaline solution, that the two solutions may be mixed as little as possible in this part of the process. The bottle must now be kept perfectly still, covered with a piece of paper, to prevent the admission of dust for three weeks or a month. Time would be saved by having a dozen bottles thus charged, and examining their contents at stated intervals, according to the chief object sought for in the experiment. The soluble salts of lime to be decomposed by the subcarbonate of potash are contained in the gum, in combination with malic acid, and also in the common water; ammoniaco-magnesian or triple phosphate is also contained in the gum, and is set free by the alkali. Muriate of lime, dissolved in a solution of gum from which all the lime had been previously separated, would answer a similar purpose, provided the muriate were not in too great excess for the gum, in which case crystals of carbonate would be formed, together with the globules, and the surface of the slide would become covered with coalescing patches of the latter. Also muriate of barytes, and muriate of strontia, when treated in the same manner as muriate of lime, furnish each a globular carbonate, the spherical form of the latter being particularly perfect and beautiful. But muriate of magnesia, when decomposed in the same manner, and under precisely the same conditions, does not furnish globules, but crystals of carbonate of magnesia, evincing no tendency to become globular."

Although gum is here recommended as the most suitable matrix, it must be noted that all kinds of viscid substances had been used in the series of experiments, and that gum was finally chosen because the most perfect globules were obtained under its influence.

In later experiments, not recorded in his book, but separately published, Mr. Rainey caused the mixture of the two viscid solutions to be effected on microscopic slides under large pieces of thin glass. By this method he was enabled to watch the process of coalescence day by day. Within the last month I have seen one of these slides originally prepared several years ago.

After working out with great care the building-up of the globules from amorphous molecular matter, our author

demonstrates clearly the physical nature of the whole process. He takes step by step each new condition and appearance, grapples with each, and never leaves it till it has yielded its secret. He mixes phosphates with the carbonates, and notes, as Professor Harting has noted, their modifying influence; he studies the question of crystallising force; he concludes that the globules ought to be undone by simple disturbance of the mutual attractions of their molecules, and follows the conclusion by successful practical proof.

He now proceeds at once to point out that simple physical laws are capable of leading to the construction of many structural forms found in living bodies. He demonstrates this in the globular calculi observed by him in the urine of the horse as early as 1849; in the shells of Crustacea and Mollusca; in bone, in tooth, in the half-bony tendons of birds; and he is not stopped after exhausting those formations in which earthy matter takes a part, but he boldly applies his principles to the structure of the sclerous tissue of vegetables, of starch-globules, of pigment-cells, of glomeruli, and of the lens of the eye.

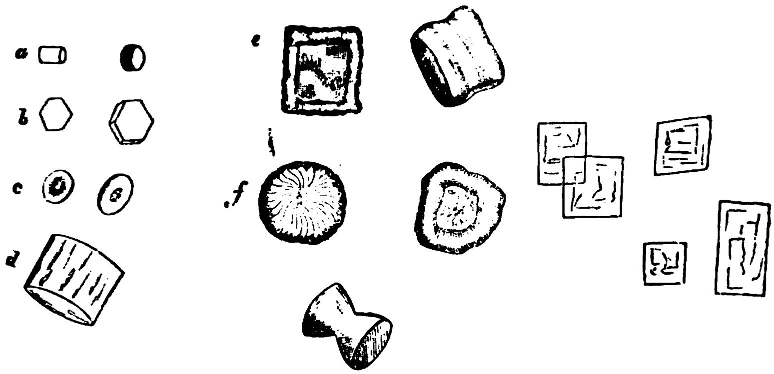
The spirit of patient exhaustive research which enabled Mr. Rainey to accomplish all these results has wrought very remarkably upon those who have been fortunate enough to come under his teaching at St. Thomas's Hospital. There are, I am well assured, many who have learned to reconsider conclusions and theories, and to avoid error, by regarding facts in the conscientious manner of their teacher.

It was fitting that original observations of such value should be applied further in elucidation of particular appearances where explanation of such appearances was wanting or unsatisfactory. As one of Mr. Rainey's pupils, I hope to be pardoned if after sketching what he has done I follow with an account of more recent observations of my own. In 1870 I showed that the great variety of forms assumed by uric acid in urine might be at least in part explained by the nature of the associated constituents in each case. It was found by experiment, for instance, that where uric acid was deposited in the presence of albumen it took the form of either small crystals with rounded angles, or of dumb bells, or of sub-spherical bodies, or even of spheres. (See fig.)

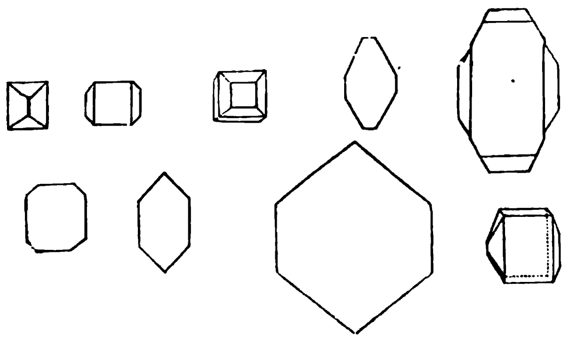
On the other hand, in the presence of sugar, starch, and glycogen the uric acid took a more or less regular lamellar form with sharp angles (see fig.); and in the presence of gelatine the forms were intermediate between the other two (see fig.).

Similarly in a series of observations upon albuminous

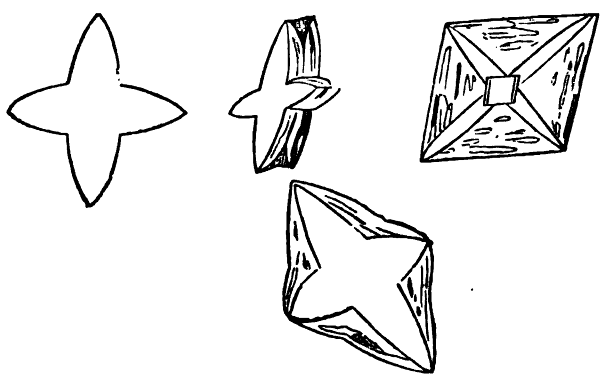
urine the acid was found always taking the form of short, stout, barrel-like crystals, with rounded sides and angles, or

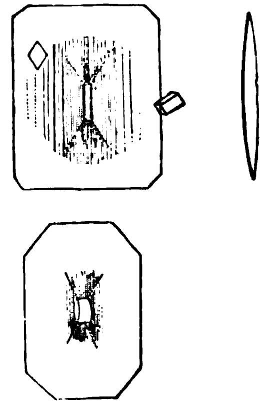


making approach to dumb-bell shape; and the adjoined cut



illustrates very well the flattened tubular form in which uric acid is deposited from diabetic urine.





Concurrently with the above observations I was engaged in a wider investigation of somewhat similar nature.

In December, 1868, while examining some urine I met with dumb-bells of a kind quite new to me; and, consulting Dr. Beale's work on 'Urinary Deposits' (3rd ed.), I found that he had made drawings of dumb-bells of oxalate of lime contained in transparent casts of renal tubes, accompanied by octohedra floating in the surrounding fluid. In his remarks upon these forms I found arguments adduced—1st, to prove that the dumb-bells were, in fact, composed of oxalate of lime; 2nd, to explain the assumption of the dumb-bell form in such cases by considerations founded upon the investigations of Mr. Rainey, which show that the presence of viscid organic matter prevents crystalline substances from assuming their usual form, and causes the crystalline matter to be deposited in spherical or dumb-bell shape. I resolved to apply a modification of Mr. Rainey's plan of experiment to the determination of some of the conditions under which dumb-bells might be formed; to fix with more certainty the relations between the octohedron and the dumb-bell of oxalate of lime; to try, in fact, to turn the one into the other, and set rest any remaining doubt as to their identity. The first experiments were made in the following way.

Some perfectly clear jelly prepared from isinglass, was melted in a flat-bottomed jar, in quantity enough to form a layer three quarters of an inch deep. In this, while still liquid, a number of glass tubes, each about four inches long, half an inch in diameter, and open at both ends, were placed upright, so that each tube was immersed to the depth of

nearly three quarters of an inch. After cooling, the tubes were removed, and each was found plugged with firm clear jelly, so as to be thoroughly water-tight. Six of these tubes were next filled with a slightly alkaline solution of potassium oxalate, and placed with plugged ends in a weak solution (about 6 grs. to 1 oz.) of chloride of calcium, the level of the solution in the tubes being much higher than the level of the calcium solution. The plug of jelly was thus interposed between the two solutions, in the hope that, diffusion slowly occurring, the results of the mutual decomposition of the oxalate and calcium salt might be found after a time in the jelly, a fair representative as far as consistence was concerned of the casts of the kidney tubes. The experiment was performed in a room of the average temperature of 57° Fahr.

On the second day the plugs were clouded with white deposit, and fragments removed from them were found to contain a large number of crystalline and rounded forms, including both octohedra and dumb-bells.

The process was then allowed to go on for three months, till, on the 12th March, 1869, an entire and uninjured plug was removed and submitted to careful examination. The oxalic solution was still clear; the calcium solution was thickened with deposit of calcium oxalate, but the relative levels of the solutions were unaltered. The plug was found free from decomposition, and opaque with earthy deposit. The deposit was not uniform, but somewhat stratified, forming a layer of greatest density near the calcium solution, a layer of less density with some opalescence near the oxalic solution, and several intermediate layers of still less density, with alternate spaces of extreme scantiness of deposit.

Transverse sections of the plug were made at thirteen points; the sections were transferred to glass slides, melted with the gentlest possible heat, and examined under the microscope with the half-inch objective. For preservation they were afterwards slightly dried at a gentle heat, and mounted in a solution of Canada balsam in chloroform. In this course of preparation it was found that, although a great variety of forms were present in the several sections, one only, the octohedron, was altered; the rest remained for many weeks unchanged, a point which was easily determined by comparison with fine sections of subsequently prepared plugs placed on slides without use of heat or balsam.

To sum up the results of the examination of the thirteen sections, it was found that the forms existing on the side of the oxalate were very different from those on the side of the

calcium salt, and that a remarkable series of gradations led easily from the one set of forms to the other. At the calcic end two forms were most abundant—perfect octohedra, and large tabular crystals of oblong outline with rounded angles. The tablets, when seen lying flat, were colourless, marked with diagonal lines and faint concentric shadings; when tilted up on one side, were yellowish in colour, highly refractile, longitudinally laminated, and again marked with diagonal lines; their thickness was about one third of their breadth. They might be described as consisting of a number of fine oblong plates bound together face to face, the outermost larger in all dimensions, the innermost shorter by one twelfth and narrower in proportion (Pl. XV, fig. 1, *a*, *b*, *c*). At this point also were found in smaller numbers forms transitional between crystals and coalescence bodies (non-crystalline, rounded, calculous); two paths being taken. By one the dumb-bell form was reached without loss of outline of the crystals, the molecules undergoing rearrangement within, so that a large flattened dumb-bell, with sharply cut edges, was found enclosed in the outline of a tablet (Pl. XV, fig. 2); by another much more frequented path the dumb-bell was reached through entire disintegration. In this second case smaller tablets were found to lose their sharpness of outline and to become granular, at the same time that they became marked by a line of slight continuous constriction round the middle of their long axis, the result being the formation of a small, not very perfect dumb-bell, and beyond this of complicated masses built up by the coalescence of a number of the smaller ones, and taking sometimes the form of double, sometimes of single, simple, or tuberculated spheres—mulberry calculi on a small scale (Pl. XV, fig. 3). The large dumb-bells were, as is already remarked, very perfect, their outline sharp and running in a bold unbroken sweep; their substance nearly homogeneous—though there were often indications of tendency to radiating fibrillation—and very refractile; they usually presented in each half a large cavity joined to its fellow by a canal running through the isthmus. As successive sections were examined, the tablets and the octohedra steadily diminished in size to the junction of the lower and middle third of the plug, and mixed with them were found small spherical molecules increasing in size as the others grew less, until they were moulded into large bodies in which the rhomboidal and spherical forms were engaged in a well-balanced struggle for superiority. They were at first sight oval, but were, in fact, rhomboidal with much rounded angles. Each had a tiny central cavity like that of a starch-

grain, and at the level of this a line corresponding to the plane which would join the obtuse angles divided the crystal into halves. Internally, the structure was apparently fibrous; it was, in fact, laminar, the laminæ being curiously bent and twisted in a spiral way, the little central cavity marking the axis of torsion (Pl. XV, fig. 4). Above the middle of the plug these bodies, having attained their full development, were suddenly lost.

Tablets, in some respects resembling the first, next appeared (Pl. XV, fig. 5). They were, however, much longer, and much thicker in proportion to their breadth. These, as they grew, were also modified. They became longer and expanded at their extremities, the middle transverse line being unaffected. At first each half was split, as it were, into two crystals, firmly bound together at the middle, slightly divergent at the end; then, by the continuation of the same process, each half became broken up into a number of flat rods bound together at the middle, so that the whole mass had a great resemblance to a wheatsheaf. Further subdivision, with curving and flattening of the rods, turned the wheatsheaf into a crystalline dumb-bell; still further, as the oxalic surface was approached, the forms rapidly fell in size, acquired a sharper outline, thicker waist, and, to all appearance, a central cavity. In some cases, by extreme arching over of the points, the two halves of the dumb-bell met round the middle, and so a sort of sphere was formed. Here also the octohedra which had been present throughout, and had followed the variations in the size of the associated bodies, underwent a change of form. They were flattened in the direction of one diagonal, and expanded in other directions. They next exhibited indentations midway between the angles, with corresponding outgrowth of the angles until they became distinctly cruciform. The rays of the cross presently lost their sharpness, and by transverse splitting (which never reached the axis of any ray) became feathered. In the central mass of the crystal the octohedral form could still be made out (Pl. XV, fig. 6). The principal forms altogether observed were five, viz.:—1, octohedra; 2, tablets; 3, ovoid rhombohedra; 4, calculous (coalescing) dumb-bells; 5, wheatsheaves, and crystalline dumb-bells. The coalescent forms were characteristic of the calcic end, the crystalline of the oxalic end of the plug. It was further evident that certain kinds of tablet were in distinct constructive relation with the two kinds of dumb-bell and the ovoid bodies respectively. It was evident also that the object originally proposed had been attained; in the presence of such a colloid as gelatin oxalate of calcium

did assume the form of the dumb-bell and of allied calculi; and, further, a comparison of the bodies now obtained with figures given by Dr. Beale and others left no doubt that many, at least, of the dumb-bells found in urine by different observers were composed of oxalate of lime.

But more than this was to be learnt. The meaning of the great variety of the crystals, the conditions determining the formation of each, and the relations held by them each to each, must be sought for.

To begin, similar experiments were instituted with solutions of calcic chloride and sodic bicarbonate, with a view of reproducing the beautiful spheres originally figured by Mr. Rainey. It was here noticed that when the sodic carbonate was in considerable excess only a few spheres were formed in the neighbourhood of the calcium solution, the middle of the plug being filled with large ovoid rhombohedra closely resembling the bodies in Pl. XV, fig. 4. The suspicion then arose that some alkaline carbonate might have been present in the oxalic solution in the first experiments, and that calcic carbonate might have been formed and modified the results. The remarkable facility with which this salt was known to be brought into spherical form by colloids made it possible that the form of the oxalate might have been affected by the presence of the carbonate. The solution of oxalate of potassium had, in fact, been rendered alkaline by a little liquor potassæ, and here was a very probable source of error.

A new series of experiments was accordingly instituted.

1. Acetic acid was added in considerable excess to the solution of oxalate of potash and all the carbonic acid expelled. The solutions being now used as before, the plug was found at the end of five days white and opaque with deposit in its lower fourth, adjoining the calcium solution. Above this it was almost clear, the acetic acid having, apparently in virtue of its greater diffusibility, driven back, as it were—outstripped (?)—the calcium salt. The deposit corresponded in the main to the oxalic end of the first plug (Pl. XVI, fig. 1). At the calcic end were "wheatsheaves" and the crystalline kind of dumb-bell, mixed with long, narrow-pointed, and very regular tablets; the octohedra were few and small. In the clear part of the plug were smaller oval tablets, and small, beautifully rounded, thick-waisted dumb-bells of nearly transparent substance enclosing a dumb-bell-shaped cavity. These forms dwindled down at the oxalic end to tiny granules, still resolved by the one-eighth-inch objective into dumb-bells, and then found surrounded with

still more tiny granules, possibly demonstrable as dumb-bells by a higher magnifying power.

2. Solutions of pure oxalic acid were placed in the tubes.

(*a*) Oxalic acid was used in large excess of the chloride of calcium. The plug was examined at the end of two days, experience having now shown, in the case at least of oxalate of calcium, such an interval to be sufficient.

Three several lines of forms were here observed (Pl. XVI, figs. 2, 3).

(1) Beginning at the oxalic end, small spicules of no very definite form were followed through many stages of aggregation to, first, the perfect and, next, the feathered octohedron.

(2) Beginning also at the oxalic end, small rounded but irregular masses were shaped into thick-waisted, clear-coloured, homogeneous dumb-bells, which became thinner waisted and more characteristic at the point where the perfect octohedra were found; underwent sudden enlargement and radial crystallisation where the octohedron became feathered, and finally assumed the "wheatsheaf" condition.

(3) At the point where the foregoing series were completed, tiny crystalline bodies appeared, soon seen as they grew to be octohedra much split up into planes parallel with the basial plane (which was oblong), and partly divided by a superficial incision perpendicular to the long axis of the oblong plane (Pl. XVI, fig. 4). The full development of this series is seen at Pl. XVI, fig. 4, in the shape of very large ovoid much facetted and laminated crystals, not unlike the large tablets of Pl. XV, fig. 1. We seemed to have here before us the changes leading from the octohedron to the tablet. Here also the "wheatsheaves" had become compressed into spheres with radiating texture and with rough spiked surface.

Just at this point the density of the deposit was so great as to draw a perfectly opaque white line across the middle of the plug, with a comparatively clear stratum below. In most of the plugs such a line existed, and appeared to indicate the point at which the two solutions balanced one another. I shall call it the line of greatest deposit. In this line only crystalline forms occurred, viz., small rhombohedra, large ovoid tablets, and large perfect octohedra. Below the line all the forms rapidly decreased in size; the ovoid crystals thinned away, by casting off their outer laminæ, till they were reduced to delicate hexagonal plates or lozenges, very transparent and symmetrical; a further simplification of outline by growth of certain sides at the expense of others produced the rhombic form; and finally, at the calcic extremity, the

only crystals left were three-sided prisms with shallow pyramidic ends (Pl. XVI, fig. 5).

The series constructive of the large octohedra requires some special description. The little spicules before mentioned as having no very definite shape were first gathered into radiating tufts; the tufts became cruciform, with very irregularly outlined arms; then six-rayed, with arrangement of rays corresponding to the angle-joining lines of an octohedron; by the filling up of the inter-radial spaces, and simultaneous smoothing of surfaces and pointing of angles, the perfect crystal was obtained.

It was constantly to be observed that the cruciform bodies were joined in pairs face to face by a bar, so as to resemble the amphidisci of Spongilla; the two halves then correspond to the two pyramids into which an octohedron can be divided, and the bar joining them to the line joining the apices of the pyramids, or third axis of the octohedron.

(*b*) Chloride of calcium was used in large excess of the oxalic acid.

The line of greatest deposit was here removed to the upper end of the plug. The constituents of the deposit were the same as in the preceding experiments, but above it very few of the forms seen in the corresponding part of the plug in the preceding experiment had been deposited; there were no octohedra, their place being taken by little rhombs. It was found that all the oxalic acid had been withdrawn from the solution, and the predominance of the calcic solution seemed to have driven away all the forms characteristic of the oxalic side.

3. Solutions of ammonium oxalate carefully purified by repeated crystallisations, and of chloride of calcium of known strength, were prepared.

The formula of ammonium oxalate is given in Miller's 'Elements of Chemistry' as follows:—

$$(H_4N)_2C_2O_4,H_2O=142;$$

of calcic chloride in the fusible form as follows:—

$$CaCl_2,6H_2O=219.$$

from which it can be calculated that 100 parts of calcic chloride will be decomposed by 65 parts of ammonium oxalate. The solutions were therefore made to contain respectively 100 grains of calcic chloride and 65 grains of ammonium oxalate in four ounces of distilled water.

Experiments were now carried on with more exactness:

1st, with equivalents of the two salts;

2nd, with 4 equivalents of oxalate to 1 of chloride;

3rd, with 1 equivalent of oxalate to 4 of chloride.

The plugs, removed simultaneously at the end of six days, were found very differently charged with deposit. In all, the precipitate was confined to the upper (oxalic) half of the plug, leaving the lower (calcic) half quite clear.

In No. 1 the deposit was divided into two strata; the lower, a little less than half, denser; the upper, rather more than half, more scanty.

In No. 2 a narrow line of excessive density ran along the lowest part of the deposit, leaving the portion above rather less dense than the upper part of No. 1.

In No. 3 a very dense deposit filled the upper half of the plug, except at a very thin line in contact with the oxalic solution. In all three cases the denser tract of the plug contained coalescence-forms with octohedra. On the side of the oxalate were large wheatsheaves, bundles of crystalline plates looking like packets of docketed letters tied tightly round the middle, and octohedra of moderate size with much-broken angles (Pl. XVI, fig. 6).

On the calcic side the wheatsheaves were replaced by smaller, rounded, homogeneous dumb-bells of great beauty; the octohedra were much larger, flattened in the direction of their perpendicular axes, and much drawn out at their angles, their internal structure being at the same time disturbed. The upper scantier layer of deposit contained in all three cases the same forms—a series running from granular exudations of crystalline matter to tolerably perfect octohedra, without any associated coalescence forms. In the lower half of the plug, just below the dense line, was a shallow layer of exquisitely perfect small octohedra, with their three axes nearly equal. Below this layer the plug contained nothing. Comparing the plugs in other respects, it was noted that the coalescence-forms were most abundant in the broad tract of No. 3, most perfect in the thin dense line of No. 2, where the wheatsheaves were so luxuriant as to form spheres of radiant crystal, and the dumb-bells were compacted into lustrous spherical beads.

4. Lime water and oxalic acid were now used in the beaker and tubes respectively; but the oxalic acid was evidently much more diffusible than the lime, and the plugs were filled with a slight deposit, corresponding in the main to the upper scantier deposit of the foregoing experiments, and contained only a few tables and bundles of plates at the very lowest point. When equivalents were used, all the forms were small, and the tablets were little oval-pointed lozenges. When two equivalents of oxalic acid and one of lime were used, the

tablets were rounded at the ends, thicker, often laminated and compressed or constricted in the middle, indicating the early stages of wheatsheaf formation.

Reviewing the whole group of experiments, it is evident—

1. That when deposited in gelatin, calcium oxalate assumes many forms, including, besides the characteristic octohedron, dumb-bells of two kinds, crystalline and homogeneous, tablets and prisms of several kinds, and variously shaped calculi.

2. That the octohedra, tablets, wheatsheaves, and crystalline dumb-bells appear to stand in direct serial relation to one another; the granules, calculi, and homogeneous dumb-bells having among themselves a similar relation. Crystals, however, may be resolved into homogeneous dumb-bells in two ways—either by a formation of dumb-bell within the outline of the crystal, or by total disintegration of the crystal, which is converted in mass into a non-crystalline dumb-bell.

3. That there is usually observed in the plugs a "line of greatest deposit," corresponding, apparently, to the point at which the diffusive force of the two solutions is balanced. On the calcic side of this line homogeneous or "coalescence" forms, on the oxalic crystalline forms, predominate. Excess of oxalic or oxalates is favorable to the size and perfection of the form generally; with excess of calcic salt, the coalescence-forms are immensely increased in numbers but decreased in size.

Where the oxalic acid predominates, crystals are mostly broken up at their angles and laminated; where calcic salt predominates, they are flattened, drawn out at their angles, feathered, or are small, perfect, and extremely symmetrical. The causes which may produce these differences may be, and are probably, of several kinds, namely:

a. The formation of basic, neutral, or acid salts, according as the solutions balance or in turn prevail.

b. The formation of double salts.

c. Alterations in the firmness or chemical constitution of the gelatin. It was generally noticed, in reference to this, that the chloride of calcium tended to soften the gelatin, the oxalic acid and oxalates to harden it.

d. The presence of undecomposed salts of different solubilities would probably, in each case, tend to modify the form in which deposit occurred.

4. That in the first experiment the presence of calcium carbonate rendered the results different from those observed when the presence of carbonic anhydride was avoided. And here new questions arose:—Why should carbonate and oxa-

late of calcium, when they had once ceased to be crystalline, assume different coalescence forms? This might be due to the fact that, their crystalline form being different, their molecules still tended to repulsions or attractions among themselves in certain directions, and so modified the sphere-forming force, or their different degrees of hydration or of solubility might have influence. The lines of weakening of the cohesion of crystals must evidently be carefully noted.

Before complicating the evidence by using solutions of other salts than those mentioned, it became desirable to determine whether the action of the colloid upon the oxalate and carbonate of calcium could be modified by the influence of the various physical forces. The curious viscosity of magnetism —first, I believe, demonstrated by Faraday, and clearly described by Professor Tyndall in his work on Heat—here suggested itself as not unlikely to intensify the viscosity of the colloid.

Common horse-shoe magnets of moderate power were at first used. In some experiments, the plugged tubes being arranged as in the first experiment, the magnets were so placed that the line of greatest deposit would run between their poles, in other cases, so that the length of the plug would be parallel to the line joining the poles. In other experiments little jars were partly filled with gelatin imbued with chloride of calcium, the poles thrust into the gelatin while warm, and the jars, on cooling, filled up with solution of oxalate of ammonia. The general result was that there was an extraordinary increase in the size of all the forms, crystalline and non-crystalline, where the plug or gelatin was subjected to the action of magnetism, but that there was no production of new forms or greater tendency to sphericity (Pl. XVI, fig. 7).

Similar experiments were made with an electro-magnet capable, with the means at hand, of sustaining a weight of thirty pounds. Some of the crystals in several cases appeared to have their axes slightly twisted; it would be very interesting to know if this and the direction of the axis generally bore any relation to the direction of the interpolar line, a point to which I intend to recur at some future period.

At the time of making these last experiments I was under the impression that the so-called viscosity of magnetism was a condition of resistance by inertia; but Mr. Charles Brooke has made me aware that he has proved this viscosity to depend upon the existence of strong spiral currents in the magnetic arc. At about the same time I had come to doubt whether the sphere-forming influence of colloids was a simple act of passive resistance. The perpetual change characteristic

of colloids—the ceaseless rearrangement of their constituent elements, which made Graham call colloids the dynamic form of matter—suggested that they must be the seat of infinite molecular movements or vibrations, such as would tend actually to break the lines of crystallisation. Clinging still to the old notions of chemical fixity, holding still to the idea that when the composition of a given colloid was once accurately written down in equivalents, its position was decidedly established, I had forgotten that these complex substances had in each case a natural history, a story of metamorphosis which must draw into its pages a record of rearrangement of any inert stuff thrown into the meshes of the colloid. Already I had used words and expressions which, as they seemed most applicable to the processes I was watching, might well have suggested to me, while I used them, that their fitness rested upon their being directly true, instead of being metaphorical. "Grasp" and "relative strength" were expressions of this kind. Experiments made with reference to the effects of temperature bear importantly on this point.

In some plugs prepared during the second week of February, 1870, when very firm and strong gelatin was rendered still firmer by the prevailing cold, hardly anything except octohedra and their immediate derivatives (macles, &c.) were found. It was then remembered that coalescence forms had been abundant and well formed in the softened plugs of the summer experiments; and although experience had shown that, other things being equal, a denser plug was favorable to the perfection of the coalescence forms, it was now evident that the vibrations of heat, and possibly of light, must be looked to as likely to aid the production of spherical forms by disturbing the lines of crystallization and throwing the molecules into the power of the colloid. Five different positions were secured for strong plugs placed between equivalent solutions of oxalate and chloride.

1. Kitchen, mantel-piece, temperature 55°—65° Fahr., in bad light.
2. Study, near window, temp. 35°—56°, good light.
3. Study, cupboard.
4. Garden, good light, temp. 27°—45°.
5. Garden, dark shed.

It was intended to take into consideration here the effect of light as well as of heat, but no decisive results were obtained with regard to the former force. On the other hand, the influence of temperature was made beautifully evident. In the kitchen specimen the coalescence forms were three or four times as numerous as the crystalline. In the garden

specimen this condition was more than reversed. The crystals were at least ten times as numerous as the coalescence forms, and were, on the average, more than twice the diameter of the crystals in the warmer specimens. It will be noticed that the crystalline form here remains perfect as long as the crystal does not exceed a certain size. In the small crystals the force of crystallization is strong enough to resist the surrounding forces of disturbance. When the length of the axes is extended, and the relations between the more widely separated molecules become weaker, the line is broken and disintegration of more or less completeness follows; just as liquids in small quantities will form drops, but only drops of a certain limit of size for each kind of liquid.

Experiments were also made with electricity, but were so much complicated by electrolysis as to give no satisfactory results.

The next step was to institute comparisons with other salts. Triple phosphate was first experimented on, the plug being interposed between a solution of hydrodisodic phosphate (phosphate of soda) and chloride of ammonium on the one hand, and of sulphate of magnesium on the other.

In the neighbourhood of the magnesic solution were found small, not very perfect, crystals of the "house-top" form. In the middle of the plug were large scattered masses, plainly visible to the eye, often more than a line in diameter, and consisting each of a central spherical body with many radiating stalactitic arms, composed of aggregated and overlapping prisms. The edges and angles were sharp on the magnesic side, rounded, in conjunction with greatly diminished size of the masses at the phosphatic end. Near the phosphatic end were subspherical, or crescentic, or unsymmetrically sheaf-like tufts of fine radiating needles or raphides, easily broken up by pressure. All these forms depolarized light, the larger with brilliant play of colour, the smaller with alterations of light and darkness. Phosphate of calcium showed an equal power of resisting the influence of the colloid. In Mr. Rainey's experiments it had been noticed that the addition of phosphate to carbonate of calcium had up to a point been attended with the production of larger and more perfect spheres; but the spheres were unstable, and easily reverted to a crystalline condition, and when a certain excess of phosphate was attained spheres could no longer be produced. But it was certain that the phosphates entered largely into the constitution of the hard bony structures of animal bodies, and that the form in which they were therein

deposited partook rather of the "coalescence" than of the crystalline type. Now, in the human body at least, the conditions existing, particularly during the period of most active growth, included the presence of albumen, and a temperature much higher than had been used in any of the foregoing experiments. Albumen, too, after coagulation, could be used at temperatures which would destroy the consistence of the gelatin plugs.

Tubes were therefore plugged with albumen on the same principle as the tubes had before been plugged with gelatin.

Beakers were filled to the depth of three quarters of an inch with fresh white of egg, the tubes were introduced, and heat gradually applied by means of a water bath till the albumen was thoroughly coagulated. When this was carefully carried out, with a temperature not exceeding 200° Fahr., the plugs were firm, homogeneous, and water-tight, no leakage occurring after the tubes had been filled with water and left for twenty-four hours.

Oxalate of calcium, deposited in these plugs at a temperature of from 50°—60°, took almost entirely the coalescence form.

When a plug was carefully examined, it was found firm and bluish in colour at the oxalic end, soft and yellowish at the calcic. In the third next the oxalate, no forms whatever of crystalline or coalescence order existed, but the albumen was remarkably fibrillated.[1] Below this appeared, in small numbers, large perfect homogeneous spheres, isolated, refracting light energetically, and polarizing with one very perfect cross. Lower down these had decreased in size, increased in number, and begun to coalesce with each other, forming here and there very perfect dumb-bells, and further on, large confused calculi, of which the line of greatest deposit was in chief part composed. As to crystalline forms, only one was present—the feathered octohedron, much depressed and much drawn out at angles, large enough to fill, when seen flat, the field of a half-inch of considerable angle of aperture; composed, when seen sideways, of two plates joined face to face, with a boss or enlargement at the middle, where generally a small coalescence sphere could be seen. Albumen was evidently much more active than gelatin in controlling crystallizing force.

Triple phosphate being used, the stalactitic crystals were found turned into rounded rods, bulging at many points into beads, and variously bent, twisted, and interwoven, so as to

[1] *Query.*—Did this indicate combination?

bear some resemblance to the form in which earthy matter is deposited in the skeletons of some of the Echinodermata. In the month of April oxalate of calcium, triple phosphate, and phosphate of calcium, were severally deposited in albumen at temperatures of 75°—85° Fahr. The oxalate was obtained in perfect spheres, having radiant but no concentric markings, and greatly exceeding in size any regular forms hitherto obtained.

The phosphates were found in irregular, elongated, curved, and branching masses, which were neither decidedly crystalline nor decidedly calculous in their internal constitution, but were composed of subcubical fragments, mostly of small size, but by no means uniform, agglomerated in an irregular way.

At this point the scope of the investigation widened considerably. The light thrown upon the nature of the physical conditions under which earthy matter was deposited in animal bodies was sufficient to indicate the great importance of the colloid bed and of the temperature. At once the difference of texture of bony matter in warm- and cold-blooded animals was remembered, and the curious connection between the temperature of the body of animals and the persistence or abolition of sutures, long ago recognised by comparative anatomists, seemed capable of explanation by the facts and the reasonings here founded on them. Bones of the fish are seen interdigitating in the most complicated way without losing their identity. In the reptile they are gathered up into more compact though still isolated masses, the long persistence of lines of suture being very characteristic of the class. In the mammal sutures are compacted for the most part in adolescence; but in the short-lived bird, with its high temperature, sutures are lost in a few months, and a compaction of bone-tissue hardly seen elsewhere is obtained. It is fair, I think, to attribute this early and complete compaction to the activity and extent of the vibrations of molecules produced by higher temperature. The linear formations of crystallization are here most thoroughly disconcerted. Stated broadly, the three most important or, at least, most abundant constituents of these several forms of bony tissue are on the one side a form of animal matter yielding gelatin, and on the other phosphate and carbonate of lime. In a series of experiments albumen was taken as the animal basis, in which carbonate and phosphate of calcium were first deposited separately at different temperatures, and afterwards deposited together in the proportions which they would bear to each other in bone.

A table, to be found at page 20 in vol. i of Owen's 'Anatomy of Vertebrates,' being taken as a guide, solutions were arranged to give by mutual decomposition the following proportions:

64·4 phosphate,	7·03	carbonate	of calcium,	as in	hawk.
59·6 „	7·3	„	„	„	man.
52·6 „	12·53	„	„	„	tortoise.
57·3 „	4·9	„	„	„	cod.

The first two were placed in hot beds of different temperatures, the hawk quantities in the warmer; the others were left in a cool room, so that the temperatures of about 85°, 75°, and 60° Fahr., were severally obtained. It followed that, in warmth or in cold, phosphate of lime was evenly distributed through the albumen in definite strata, not forming crystals or spheres, but cementing the albumen to great hardness, particularly at the line of greatest density. Carbonate of lime, on the other hand, never failed to form spheres at the highest temperatures used. At the lower temperatures, however, it took very remarkable forms. In certain strata were found spheres of very regular size, having a much smaller diameter than the spheres formed at ordinary temperatures, and these spheres were closely beset with transparent often curved and pointed spines, so that the whole structure came to resemble the spiny spores of some of the Desmidiæ. These spines were evidently attempts at crystallisation, which, as before noted, is favoured by cold, and which would be able to assert itself when the spheres had attained a certain bulk, and radial attraction had thereby been sufficiently enfeebled. Indeed, in some cases they were so arranged as to form a sketch of rhombohedron investing the central sphere.

In the bone-salt experiments a nearly uniform result was obtained throughout. The carbonate of lime was subdued, so to speak, by the phosphate, and an even subcrystalline but continuous deposit was produced. With transmitted or reflected light no spheres could be seen, but with polarized light indications of their existence were in some parts manifested by crosses of faint white and black. The use of a phosphate as a cement and manipulator of the less tractable carbonate is well indicated in these experiments.

The strength of the carbonate seems necessary in all hard tissues that have to be tough. But the carbonate alone does not appear to be fitted to form tissue destined to be the seat of active interstitial change. With the bird's high temperature and great vital activity, therefore, we see associated a great predominance of phosphate. In the tortoise, with its low temperature and sluggish processes, a great decrease of

phosphate and increase of carbonate; and in the shells of the invertebrata, where interstitial change does not prevail, the carbonate alone, or with little phosphate, suffices. In the case of the cod this line of reasoning does not at first proceed so clearly. There is far more phosphate and far less carbonate than in the tortoise. The explanation is probably to be found in the nature of the animal matter with which the salts are associated. Throughout the tissues of the ordinary bony fish there is less compactness and tenacity than in the tissues of the higher vertebrata. Any one who has dissected fishes knows how much care is required to avoid laceration of the parts that may be handled freely in a rabbit or a bird, and the very difference exhibited in the matter of firmness by the cooked flesh of birds and the higher animals is to the same effect. At present I have no distinct information on this point, but I feel justified in suggesting that the remarkable difference in the proportion of the earthy salts is determined by association with a less powerful and characteristic colloid, the greatly diminished carbonate still requiring a large excess of phosphate to reduce it to docility.

To one part of Professor Harting's statement much importance should, I think, be attached. He asserts that the albumen combines with earthy matter, and is transformed into a new substance, or a substance with altogether new reactions, named by him "calcoglobuline." This is probably an illustration of a kind of combination which frequently occurs. For example, some forms new to me having occurred in some electrical experiments, I caused oxalate of copper, in one instance, and carbonate of copper in another, to be precipitated in gelatin. The oxalate formed beautiful green spherules. But in the other experiment no deposit occurred. At the line where the carbonate would be formed in the plug the gelatin was found extremely transparent, of a very bright emerald colour, and almost equal to india-rubber in firmness and resilience; the sodic side of the plug was softened and purplish in colour; the cupric side was unchanged. I am inclined to believe that similar alterations of physical properties by combination are the essential conditions in the action of some mineral medicines upon particular tissues, and am at present making this matter a subject of experimental inquiry.

Recent RESEARCHES *in the* DIATOMACEÆ.

By the REV. EUGENE O'MEARA, M.A.[1]

THE second of a series of treatises in course of publication under the direction of Dr. Johannes Hanstein, under the title of 'Botanische Abhandlungen aus dem Gebiet der Morphologie und Physiologie,' is eminently calculated to interest such as are engaged in the study of the Diatoms, and promote their knowledge of these interesting and ornamental organisms. These benefits, however, must be confined to those students who are acquainted with German, unless some one undertake to remove the obstruction, and present the treatise in an English dress.

Dr. E. Pfitzer's 'Untersuchungen über Bau und Entwicklung der Bacillariaceen (Diatomaceen)' deserves more than a passing notice, and therefore, in justice to the author, as well as with a view to the benefit of my fellow-labourers in this field of research, I shall not content myself with directing attention to some of its most salient points, but shall, in a few papers, give a brief analysis of the entire treatise.

With great justice, the author remarks that since Nitzsch and Ehrenberg opened up the path to this interesting field of observation, very little has been added to our knowledge of the structure and development of the soft contents of the diatomaceous frustule, notwithstanding that many distinguished men, in different countries, have devoted themselves to the study of the Diatoms. This failure is to be accounted for by the fact that most observers have come to the examination only after the organic parts have been destroyed by acid or burning. And I would invite the special attention of my fellow-labourers to the observation of our author, that so partial an investigation cannot continue without injurious effect on the growth of our knowledge of this group. The task which Dr. Pfitzer has proposed to himself is by a series of careful observations to prove the accuracy of Meneghini's observation, "That anatomy has to effect the same beneficial revolution in the Natural Classification of *Diatomaceæ* as has been produced in the system and nomenclature of Conchylia." This arduous enterprise he entered on with full confidence of ultimate success, and aided by a very extensive acquaintance with the literature of the subject. I would take occasion to recommend my fellow-labourers to make themselves

[1] Reprinted (by permission) from the 'Journal of Botany,' March and May, 1872.

acquainted with Heiberg's book, 'De Danske Diatomeer.'[1] The labour of acquiring a knowledge of the Danish language will be well requited by the profit and pleasure they cannot fail to derive from its perusal.

A patient and careful examination of the several species of *Diatomaceæ* in the direction indicated by Dr. Pfitzer, even in the hands of men much less competent than he is, can scarcely fail to contribute most important additions to our knowledge on the subject. At the same time, there is reason to doubt that a more satisfactory system of classification than we have at present is likely to be established. A considerable number of the known species of *Diatomaceæ* are fossil, and for this reason are beyond the reach of such observations; but if these researches contribute to verify in any degree the correctness of the present system of classification, to make clear what remains doubtful, or to rectify mistakes that may have been made, the labours of Dr. Pfitzer will have proved eminently successful.

Deferring my remarks on the direct results of Dr. Pfitzer's observations to my next paper, I shall now refer to two matters of interest noticed in the introduction.

The name *Diatomaceæ* has been used by nearly all the more recent authors to designate the group. Rabenhorst, in his more recent work, has adopted the name *Diatomophyceæ*, but in his former treatise used that of *Diatomaceæ*, "die Süsswasser Diatomaceen;" and in this he has been followed by Grunow, Heiberg, Schuman, Cleve, and Suringar. Dr. Pfitzer, however, maintains that the name *Bacillariaceæ* should be substituted, the genus *Bacillaria* having been established by Gmelin in 1788, whereas the genus *Diatoma* was established by De Candolle in 1805; and some of the older writers on the subject have used this designation. It may be deemed inconvenient now to abandon the name of the group which has been so generally adopted by recent writers, but, on technical grounds, Dr. Pfitzer's view is undoubtedly correct.

The most interesting portion of the introduction is, perhaps, that in which the author sketches the gradual progress of knowledge regarding the true structure and development of the diatomaceous frustule, from its first dawn to the present moment. The bivalve character of the frustule was known before adequate notice had been taken of the hoop, or connective membrane, which binds the two valves of the frustule together. An even after the importance of this part of the

[1] A critical review of this book will be found in 'Journ. Bot.,' 1864, pp. 321–323.

frustule had been to some extent recognised, its true structure and its relation to the development of the plant were overlooked.

Wallich, in 1858, observed that in the case of *Amphitetras Triceratium* and *Biddulphia*, "the hoop consisted of two pieces, which at first entirely overlap each other, but as the process advances, recede from each other, and whilst so receding, appear like three distinct parallel annuli, the centre being less diaphanous, and its markings more confused, in consequence of its being in reality the overlapping and double portion referred to." Wallich still further contributed to establish a true conception of the mode of growth in the hoop, by proving that in the families above specified, "the growth of each plate of the connecting membrane takes place at the margin furthest off from the valve to which it is attached." Pfitzer endorses the accuracy of Wallich's views, and expresses an opinion that greater value attaches to this discovery than even to that of the bivalve character of the frustule.

Presuming the separate plates of the connecting membrane to be in all cases as Wallich describes them, "marginal extensions of the valves perpendicular to their general plane," and that the formation of the new valves takes place within it, the effect of these conditions on the growth of the future frustules must be obviously to effect a gradual diminution in the size of the valve equivalent to the thickness of the siliceous plate of the hoop.

In the year 1869, Dr. M'Donald, in his interesting paper "On the Structure of the Diatomaceous Frustule and its Genetic Cycle" ('Ann. and Mag. of Nat. Hist.,' 4 ser., vol. iii, 1869, p. 1), adopts the theory of Wallich concerning the structure of the hoop, and traces out its effects on the development of the frustule. "As each perfect frustule consists of an older and a younger valve, never of two valves of the same age, Kützing's names—primary as applied to the former, and secondary to designate the latter, or the invaginated valve—can be open to no possible objection. But to these it is absolutely necessary to add two tertiary valves of the same age, resulting from the process of fission, viz. the first tertiary developed in connection with the primary valve, and the second tertiary forming a new frustule with the secondary valve."

The process of diminution in each successive frustule goes on until the minimum is reached, when the frustules conjugate, and from this operation arises a sporangial frustule, in all respects similar to its parents, but double the size.

Within a few months after the important discovery of Dr. M'Donald had been made known, and before the paper had come under the notice of Dr. Pfitzer, the latter had worked out the same conclusion, thus corroborating the views of Dr. M'Donald, without derogating in the slightest degree from the credit due to himself for his own independent observation.

It must be remarked that the theory just stated as to the nature of the hoop and its bearings on the development of the frustule, has been established only in regard to the genus *Biddulphia* and its kindred families. The supposition that the same character belongs to the hoop in the other numerous genera is but a presumption—a very natural one, indeed, but still it needs confirmation.

This fact opens up a wide field for research, and it is hoped that the numerous students of the *Diatomaceæ* throughout the world will be prompted to follow out the track the discoveries of Wallich, M'Donald, and Pfitzer have indicated.

II.

The subject of the former notice of Dr. Pfitzer's useful and instructive treatise was the structure of the external siliceous epiderm of the *Diatomaceæ*. The information afforded by the author on this subject cannot fail to interest the most experienced student of these forms, and much of it will be quite new to those who have been satisfied with a superficial inspection of the most obvious characters of the diatomaceous frustules.

My present purpose is to convey to my readers the views of the author regarding the contents of the cell; a department of the subject which has not received the attention it deserves. There are many students who confine their attention to frustules which have been treated with acid; to such the characters of the cell-contents must be altogether unknown. There are others, it is to be feared relatively few in number, who, not content with such superficial knowledge, desire to understand the most recondite details of structure. Such researches are attended with considerable difficulty, in consequence of the normal condition of the cell-contents being affected by circumstances, and the application of reagents being often necessary to bring out the details with sufficient distinctness. The information given by Dr. Pfitzer on the structure of the cell-contents of the diatomaceous frustule is therefore the more important and deserving of attention.

It is necessary to premise that the views here expressed have special reference to the *Naviculaceæ*, but are, with some modifications, more or less appropriate to the other genera.

Attention is first directed to the plasm-sac (Plasma-schlauch), consisting of a fine colourless plasm forming a closed sac of the shape of the cell, and which in the *Naviculaceæ*, as in all the other *Bacillariaceæ*, envelopes the cell-contents. It is often very difficult for the observer to make himself certain of the existence of this sac, because its refractive power differs but slightly from that of water, but the structure becomes apparent on the application of dilute hydrochloric acid. The effect of this reagent is to produce an immediate contraction of the sac, which at first, as it recedes from the cell-wall, preserves the form of the cell, and still maintains connection with it by a few pellucid threads, but after some time becomes contracted into a round mass. This result is brought out most effectively by the use of osmic acid. Pfitzer informs us that *Bacillariæ*, which have been treated with a solution of the latter acid, at the strength of one per cent., may be satisfactorily preserved in a mixture of glycerine, alcohol, and water. This mixture should be applied to the edge of the covering-glass, and, after being allowed to evaporate, applied again. He further informs us, that iodine gives a bright yellow colour to the plasm-sac.

The next detail of internal structure to which attention is called, in the work under review, is what the author describes as a larger accumulation of plasma occurring in all the *Naviculæ*, and which lies transversely in the middle of the cell. This collection of plasma had been pointed out by Nitzsch. Kützing noticed it, and gave it the designation of transverse band (Querbinde). Ehrenberg describes it as being like "the embryo in an egg." Other writers also called attention to it, and finally Schülze gave the most accurate description of it in the case of *Pleurosigma*. This middle plasma-mass is discoverable on the side view in both valves, and forms generally but not universally a sort of irregular quadrangle. Vacuoles and oil-globules occur imbedded in the plasm, and appear distinctly in consequence of their strong refractive power. Here also, in the case of the larger forms, *Pinnulariæ*, for instance, have been observed with more or less distinctness short, dark interrupted lines which, in parallel pairs, pervade this central mass of plasma, but are most abundant from the centre to the cell-wall. These lines exhibit the same aspect in all positions of the frustule, and therefore are supposed by the author to be cylindrical threads of a thicker consistency than the re-

mainder of the mass, and, perhaps, analogous to the plasm-threads, discovered by Hofmeister in the plasmodia of *Æthalium*.

A third detail worthy of notice is the central vesicle, which occurs in the middle of the plasm-mass to which attention has just been directed. It is not equally distinct in all the species of the group, nor in all the individuals of the species. It is very prominent in the *Pleurosigmata*, in the *Naviculæ* proper, in *Stauroneis phœnicenteron, Pinnularia tabellaria;* and though in some cases, even with the most skilful management, it cannot be discovered, our author considers that nevertheless the statement of Luders may be correct, that no *Bacillaria*-cell is destitute of such a vesicle, because in many cases, when no such structure can be detected by the ordinary means, even with most careful examination, the application of reagents renders its presence manifest. Dilute hydrochloric acid is the reagent recommended by Schülze as the most satisfactory for this purpose.

In addition to these details of internal structure already referred to, a fourth is indicated by Dr. Pfitzer, namely, two plates of endochrome which occur in the cell of the *Naviculæ*, of a thick substance and of a yellowish-brown colour. These endochrome plates vary in shape, conformably with the outline of the siliceous epiderm; but in all the species they correspond in these particulars, namely, that they lie upon the connecting bands, and also that they pervade both valves, leaving a small space down the middle free. They do not extend to the extreme ends of the cell, and are more or less constricted at the centre; their colour varies from light yellow to dark yellowish-brown, and is of the same shade throughout in each case, though varying in different specimens. These plates consist of a plasmatic substance differing in density from the plasma forming the sac and the middle mass. In case the normal condition of the cell-contents be disturbed by fracture of the siliceous epiderm, the endochrome plates go together, and never commingle with the material of the plasm-sac. If the colouring matter be discharged by alcohol, the demarcation of the endochrome-plates from the rest of the plasm can be distinguished.

As to the colouring material, it has been proved by several authors to be a combination of chlorophyll and a yellowish substance, called diatomin or phycoxanthin, and is similar to the yellow colouring material found by Millardet in the *Fucoidæ*.

In addition to the parts already spoken of, the author has observed in the cells of *Naviculæ*, as well as in all other

Bacillariaceæ, two others, namely, a water-like fluid substance, and oil globules differing in size. These latter occur swimming freely in the cell, but abound upon the inner surface of the plasm-sac. In consequence of their strong refractive power, they strike the eye at once, and are changed into a black colour by the use of osmic acid. As they readily combine, they have no skin. The author's experience confirms the observation of Luders, that in proportion as the oil abounds, the cells have suffered from the want of pure water. The appearance of the larger oil-globules is a sign that the cell has attained its full maturity and exhausted its resources.

The oil-globules afford a means of answering the question whether the cell-contents are of a watery or of a gelatinous consistency. In favour of the former view, Dr. Pfitzer refers to the fact that very weak acid produces an immediate shrinking of the plasm-sac, as also to his observation that the oil-globules can be moved about with facility, which could not happen if the surrounding matter were of a gelatinous nature. The opinion of our author on this snbject is corroborated by Focke, who discovered that the oil-globules, in consequence of their light specific gravity, accumulate on the upper surface of the cell, and change their position in case the frustule is turned upside down.

Remarks on DR. NITSCHE'S RESEARCHES *on* BRYOZOA. By PROFESSOR SMITT.

IN the 'Zeitschrift für wissenschaftliche Zoologie,' Bd. vi, Hft. 4, Doctor Hinrich Nitsche has published his "Beiträge zur Kentniss der Bryozoa," of whom you already, in April, 1871, had received and published an extract—"On some Interesting Points concerning the Mode of Reproduction of the Bryozoa." In these excellent papers you will find a critique of my views on the subject, as well as very good additions to my observations; but I am sorry to find that the distinguished doctor in many points has mistaken my meaning and overseen my statements, without doubt because of the difficulties of the language.

Thus I never have said, and could not think any one should impute to me such a thought ('Zeitschr.,' l. c., p. 446), that the zoœcia in the common-bud differentiate themselves centripetally from the peripheral margin of the bud. Any

one who regards my figures of the budding of the *Crisiæ*, or *Diastroporæ*, or *Flustra*, even without understanding the Swedish language, will at once see that such an opinion would be an absurdity.

As to the theoretical difficulties he has raised ('Quart. Journ.,' April, 1871, p. 157) against my theory of the common-bud as belonging to the colonial life, viz. the theoretical impossibility of mere individuals in community contributing to this budding, these difficulties must disappear for the truth that younger zoœcia are differentiated from the older ones along the whole *lame germinale* (D'Orb.), before the latter are full-grown, and this with a continuity (*e. g. Diastropora*) that leaves no doubt that the budding is going on as a common function of the colony. It is principally from the *Cyclostomata* that this theory most easily will be understood; but even in the *Chilostomata*, although there the individual life is more developed, the commonness of the budding is perceptible, though it gradually approaches the simple budding by the uniserial forms (*Eucratea*, &c.).

As to the structure and development of the endocyst (mantle), Dr. Nitsche, in the most pregnant mode, confirms my observations on *Vesicularia* and *Membranipora*, and he just cites the place ('Ofvers. Vet. Akad. Förh.,' 1866, p. 519), where I have described the development of this structure in the same manner as he describes it himself ('Zeitschr.,' l. c., p. 453), but all that he knows of my observations is the notice (l. c., p. 493) that I should have doubted of the correctness of my former description of the net in the mantle.

As to his inner layer of the endocyst, the "*Spindelcell-schicht mit anliegenden Körnerhaufen*," though I have not succeeded in seeing the true "*Spindelcellen*," it is the same layer within which I have followed the development of the *polypide*, &c. This layer, which even Nitsche sometimes says to be missing, I have not separated from the "*floating cells*" in the perivisceral cavity, because, as anatomical features (as far as I have seen), they pass over into each other in their looser or closer aggregations; and as to their morphological significance and physiological function, they are developed in the same manner within the perivisceral (lymphatic) fluid, and seem to serve in the same manner for development or nutrition. Hence the whole controversy is concerning the name of that layer.

As to the so-called "nervous system of the colony," I have retained its older name, instead of giving it a new one, being unable to add anything that really could give it

another physiological significance. And, indeed, even in the excellent description of the "*Funicular-platte*" by Doctor Nitsche, I see good reason at least for studying this feature much more before leaving off the interpretation at first given by Fritz Müller. That it encloses more than nervous elements, especially in *Flustra membranacea*, is very obvious (cf. 'Ofvers. Vet. Akad. Förh.,' 1867, p. 32), but for awarding to this the physiological significance of the name of *funiculus* (Allm.), I think, is all too vague.

As to the germ-capsules, the Rev. Th. Hincks, without doubt one of the most excellent Bryozoologists, already has pointed out ('Quart. Journ. Micr. Sc.,' July, 1871) what is yet to say thereon. I did not answer the eminent Professor Claparéde upon his objections against my theory, because I hoped he would continue his researches on these animals. Death has deprived us of this most glorious labourer in the field of scientific zoology. Now, Dr. Nitsche says I am right as to the development of these germ-capsules. As to the budding from them, I still trust to my observations, only calling to mind that the budding from the endocyst in the older Zoœcia, by which Nitsche will explain the whole question, was known and described even by me ('Ofvers. Vet. Akad. Forh.,' 1864, p. 28) as a different mode of budding, that could be observed even in the atrophied zoœcia without germ-capsules.

The Luminous Organs *and* Light *of the* Pennatulæ. By Professor Panceri, of the University of Naples.

The memoir presented to the Academy under the title indicated above commences by the enumeration of the authors who have witnessed the phosphorescence of the zoophites in question. Although omitting the observers who limit themselves to stating the fact that light is emitted by the Pennatulidæ, I ought specially to mention Spallanzani, Blainville, Delle Chiaje, and Forbes, as having already described the luminous waves which are seen traversing these little polypes when they have been recently touched. Hitherto neither methodical experiments have been made towards determining the conditions of this phenomenon, nor special researches to discover whether these animals really possess true luminous organs. Formerly it was generally believed that the mucus which clothed the exterior of the branches

had the power of giving light in such a way that the finger which touched and pressed these little polypes became covered itself with luminous matter.

After the historical quotations the memoir is divided into two parts—the one anatomical, in which are given descriptions for the first time of the luminous organs of the Pennatulæ; the other physiological, in which are described all the experiments made in the investigation of the phenomenon of the luminosity. I take advantage of this opportunity to thank publicly Professor Francesco Gasco, who was my assiduous companion in these discoveries. The result of the anatomical researches may be summed up as follows:

1. In the Pennatulæ and similar genera, and apparently in all the phosphorescent Pennatulidæ, the light eminates exclusively from the polyps and the zooids (rudimentary polyps).

2. The phosphorescent organs of the Pennatulæ consist of eight cords (cordoni luminosi), which adhere to the external surface of the stomach of the polyps and the zooids, and are continued into each of the buccal papillæ of both.

3. These cords are principally composed of a substance contained in vesicles or cells, and which has all the characters of fatty matter, including that it does not decompose immediately after the putrefaction of the polyps. To these are added multipolar cells and albuminoid granulations.

In the *Pennatula phosphoria* is found besides this a mineral substance, white, granular, and indefinite in its composition, but which is neither a carbonate nor a calcareous phosphate. This matter is wanting in the *Pennatula rubra*, in the *Pteroides griseum*, and in the *Funiculina quadrangularis*, which present, however, organs and luminous phenomena similar to those of the *P. phosphoria*; hence it results that no special importance can be attributed to them. However, it renders the cords of the *P. phosphoria* very white, and thus permits them to be observed by transparency through the teguments of the little polyps. The softness and fragility of the luminous cords are such as to prevent all minute histological research. It is, then, to the fatty nature of the substance which composes these cords that it is necessary to attribute the fact that the anatomists who have studied the anatomical structure of the Pennatulæ from specimens preserved in spirit have not been able to discover these organs.

However slightly a little polyp may be compressed, the luminous cords soon break, and the photogenic matter is then able to project itself into the cavity of the tentacles, whence it is easy to collect it for observation; but if the pressure acts in the direction of the Polypidom this same

matter is found, on the contrary, thrown back into the canals of the latter. Thus it may be understood how Spallanzani, entirely compressing in his hand the stem or the base (vessillo) of a Penatulide, obtained at the extreme pore of the stem (gambo) a luminous jet. In the same way may be explained how Delle Chiaje has seen the bulb of a Funiculina shine like a lighted brand. I have myself verified the case of the Funiculina, but the light arose from the phosphorescent substance which was mixed in the milky serosity (sierochimo) of the canals of the Polypidom, and which was seen by transparency on account of the delicacy of the external tegument. I very easily recognised this matter under the microscope.

Professor Wagner, of the University of Kasan, told me he had once seen at Naples a pale light issue from the stem of a Pennatula, which would have much astonished me, after having found special luminous organs, if I had not thought it was identical with what I have cited above in connection with the Funiculines. It always happens that the luminous matter in one way or another is set in motion, either by a shock or, it may be, by regular pressure exercised upon the rachis. The light which may be created in the liquid substance to which the stem of a Pennatula is reduced by decomposition is due to the same photogenic matter which we have seen to be the last to decompose. The physiological part of the memoir commences by a chapter in which are mentioned the different conditions in which a Pennatula may be found, upon which one may study the phenomena of light. When these zoophytes, living at the depth of forty to one hundred mètres and more, are dislodged from their deep dwellings and transported to an aquarium, they undergo such a change in the pressure, the temperature, the saltness of the water, the general conditions, and, above all, the narrowness of the space, that little by little they swell prodigiously to double their bulk. In this state, which was called hydropic, as also in the tetanic state, to which the Pennatulæ are subject when they are subjected to repeated manipulation, or in yet another state, which is that of exhaustion, the inevitable consequence of a prolonged sojourn in an aquarium or of repeated experiments, the tissues of a polypid are no longer endowed with any conductability by excitation, and the polypes only yield the light when they are directly and individually stimulated.

If, on the contrary, it happens that experiments are made on individuals fresh from the sea, and, in consequence, not yet hydropic, or on others in whom hydropsy is already diminished, or generally in others which are far from ex-

hausted, we then find ourselves in the presence of a phenomenon of very great importance and of very splendid appearance. When one manipulates by chance a Pennatula which is in the state we have already called fit for experiment, in every case there is then obtained an appearance of sparks on the polypiferous edges, small lights coming and going, as if the light sprung from the finger or from the object which touches the polyp, going always from one to another. If, on the contrary, acting with much rapidity, one applies the stimulant methodically, regular luminous currents will be obtained, as if the little polyps took fire one after another, those on one branch before those of the following one, in such a way that the following conclusion is arrived at:—The fatty matter of the luminous cords may become luminous in the polyps and in the zooids, not only by the excitation acting directly on the polyp and the zooid, but also by stimulants applied to a distant point of the polypidom. In these cases the luminous currents which run along in every direction of the phalanges of polyps and zooids, evidently represent the direction and the velocity of the propagation of the excitation. In the study of the currents observation has been made, in the first place, of their direction; in the second, of their rapidity. If we operate on the basal extremity of the stalk, we shall have on the stem an ascendant luminous current. If the stimulant is, on the contrary, applied at the top of the polypidom, there will be produced a descendent current. Lastly, if the stimulus is applied to the feathered part of the *rachis*, one will then obtain two divergent currents. If the two extremities of the polypidom are simultaneously excited, one will have two currents convergent, which usually cease after a period of great vivacity at the point where they meet. I have only once seen in a very sensitive Pennatula the two convergent currents continue after thus meeting, each one their own way, as if the other did not exist. If the excitation is produced at the end of a branch, one may see the light run along the stalk, and consequently currents appear on all the other branches in the direction of the diffusion of the excitation.

Without speaking of the manner employed to measure the velocity of the luminous currents, we shall now give some figures.

The ascending current of a *Pennatula rubra* takes to run up the stem, at the minimum $1\frac{1}{5}''$, at the maximum $3\frac{1}{5}''$, at the average $2\frac{1}{5}''$.

The same current in *P. phosphora* takes at the minimum $1\frac{1}{5}''$, at the maximum $2\frac{1}{5}''$, at the average $2''$.

Having observed in all my experiments an interval be-

tween the moment of the application of the excitement and the commencement of the current, I measured it, and found it $\frac{4}{5}$ths of a second.

In certain cases the ascending current takes less time, and in others more; in one case it took 4″. The duration of the partial currents of each branch could not be estimated; it is, nevertheless, much shorter than $\frac{1}{5}$th of a second; the figures obtained for the descending current, and for the currents of the zooids, differ in no wise from those already cited. The extent of the Pennatula being, on the average, 6′ 1″ long, and the luminous current taking about 2″ to traverse it, one may presume that the same current would take 20″ to traverse one yard; one may also suppose that, if it had to traverse the 30 mètres, which the motor-excitation of the nerves of the frog traverses, according to Helmholtz, in 1″, the luminous currents of the Pennatula would take 600″, or 10′, to go the same distance; it would take 660″, or 11′, to traverse the 33 mètres which the sensation of the nerves of man and of mice traverses in 1″. In any case, the velocity of propagation of the excitation in the Pennatulidæ is 160 times less than that which was observed by Schiff in the nerves of inebriated cats, in which the transmissibility had been reduced to 8 mètres per second.

In this limited space I leave aside in this summary considerations and comparisons. I cannot, notwithstanding abstain from calling the attention of physiologists to the singular properties of the Pennatulæ, *of rendering visible by the light of their polyps the direction and velocity of propagation of excitation, as if in these animals the interior molecular movement, which is produced in consequence of the excitation, placed the content of the cells of the luminous cords in a state which allows it to combine with oxygen—a chemical action, accompanied with development of light rather than heat.*

These ascertained facts inspire the desire to know if the Pennatulidæ really have nerves. Having mentioned the observations of Kölliker, as well as my own, about the pale, thin, and transparent fibres seen in the little cells and in the muscles of the polyps, I must, notwithstanding, admit that the field remains largely open to ulterior observations, which ought to be made on polyps in general. It appears to me that, if the nervous system is existing in the Pennatulæ, it ought probably to be social, like that which has been observed in some Bryozoa—for example, in the Cerialariæ. If, on the contrary, the above-mentioned fibres were not nervous, the Pennatulæ ought to enter, and with

them, perhaps, all the polyps, into the category of animals, the nervous functions of which are not confided to special histological elements.

After having spoken at length in the memoir of the different means of excitation capable of exciting luminous phenomena in the polyps and the zooids, we must now determine what action the same agents can produce on the luminous matter after its separation from the polyps, insisting more particularly on the power which soft water exercises on the luminous matter, be it of the Pennatulidæ or be it of other animals, which will be cited further on. We arrive, then, at the following conclusions:—The luminous matter of the Pennatulæ may be directly induced to shine when detached from the polyp or the zooid, by a shock, by rubbing, by soft water, by an electric current, and by heating, not only directly after it has been extracted from living polyps, but also after their decomposition. The memoir goes on to, treat of the action of electricity, of heat, of light on the phosphorence of the Pennatulæ, and speaks also of the spectral analysis of this light. We will terminate this summary by giving various other conclusions from the memoir, which are the following:—Admitting what has been demonstrated upon another occasion—that is to say, that the phosphorence of fatty substances is a phenomenon which accompanies their slow oxidation, it appears very probable that the light of the Pennatulæ accompanies the oxidation of the fatty matter of the luminous cords. By the same reason that, in the Torpedo, the electro-motive power of the elements of the electric organs comes from the action of the will or the artificial excitation of the nerves, and in the same way that by the action of the nerves the intensity of the oxidation and the development of the heat can be augmented or diminished in a warm-blooded vertebrate, it may be supposed that the nerves of the Pennatulæ, or the elements which stand in their place, are capable of producing in the luminous batteries of the polyps and the zooids a momentary oxidation more rapid and more intense, accompanied with a manifestation of light.

The photogenic substance of the Penatules presents, in the whole of its characteristics, the greatest resemblance with the fatty matter contained in the cells of the epithelium of the phosphorent Medusæ, as also with those which I found in the Beroides, and the Pholaides, and the Chetopters, the Nocotolases sketched by Quatrefages. These matters react on the different excitements and behave as if there was in them a substance which rendered them phosphoric, and

which was the same as renders the Penatules luminous. Without denying that there may be found marine animals which, the same as the terrestial glow-worms, shine by the slow combustion of an albuminous substance, or for some other reason, it is, nevertheless, certain that some of the phosphoric animals of the sea owe their phosphoric properties to a special matter which presents all the characters of a phosphoric grease, as well as the peculiarity of becoming luminous in soft water, as in the other cases mentioned in this memoir.

The Luminous Organs *and the* Light *of the* Pholades. By Professor Paul Panceri.

In continuation of the studies already made on luminous animals, I now present to the academy a work on pholades, concerning particularly the most ordinary species of our seas, namely, the *Pholas dactylus* L. The phosphorescent properties of these molluscs has been for some time known, and the luminous clouds which they spread in water when touched or moved. Pliny describes this phenomena in a special paragraph of his ninth book.[1] His observations were afterwards confirmed by many authors, and Reaumur also wrote on this matter,[2] expressing the belief that the outer surface of the pholad creates this luminous matter, illuminating the object it touches, and the water in which one washes one's hands. According to Reaumur this same matter if dried shines again when wet. Monti, Beccari, and Galeati, as also their contemporary, Reaumur, were much occupied on the subject, and made observations which scarcely differ one from another. They maintain that pholades shine most when in milk. The authors whom I cite in my memoir confine themselves to describing the phenomenon without indicating its precise situation.

I myself once perceived the faet of the luminous clouds in the water with pholades in it when shaking and troubling it, and I also have seen their bodies luminous after opening the mantle and the valves; this is caused by an abundant liquid which communicates light to the body it touches. I then thought, since we have here to deal with a secretion, that two cases might present themselves, either that all the surface of the pholad and in all probability its exterior epithelium might be the seat, as I have seen in the medusæ and the

[1] 'Histor. Mundi.' [2] 'Memoir de l'Academie de Science.'

siphonophora, or that the luminous secretion had its source in the interior of special glandular organs. To resolve this problem I only employed a slight jet of falling water which, directed in the dark on the animal whose mantle and anterior siphon had previously been opened, carried off the exuberant part of the liquid and allowed me to see the *luminous organs* of these molluscs. I found that after washing, the light was seen to be fixed in definite places, such as, firstly, an arch corresponding to the superior edge of the mantle which reached to the middle near the valves; secondly, two small triangular spots placed at the entrance of the anterior siphon; thirdly, two long parallel cords in the same siphon. I must also observe that, if the current of water was stopped, all the body of the animal became suffused with the luminous matter, and, as before, entirely shining; thus I discovered that there exist special *organs from which the luminous matter emanates*, which has the appearance of being secreted all over the surface of the animal to observers who have not tried the washing experiment, which appears to have been the case with those who up to the present have observed the pholades. Having examined a great number of the animals in question, which were abundantly found in the Gulf of Baja, I never happened to come across one that differed from another as far as the disposition of the luminous organs is concerned. By amputating the corresponding parts to these organs, all the luminous power of the pholades is extinguished.

All these things discovered, it became necessary to know what corresponds to the places from whence the luminous matter springs. On the superior edge of the mantle there is no organ at first seen, but, on the contrary, to the parts above mentioned circumscript organs correspond, and I cannot understand how they have escaped the observations of naturalists who have occupied themselves with describing the parts and structure of molluscs. Only in Poli, who nevertheless made no special investigations on the light of pholades, do I find mention of these parts, what we have called *triangular organs* and *cords*, without his having guessed at all their attributes. "Quinam vero sit eorum usus pronuntiare non audemus."

The place of the triangular organs and the cords once ascertained, and wishing to examine them closely, one perceives that these organs are a part of the mantle on which they stand out in relief, whilst their whiteness contrasts with the gray colour of the animal. The triangular organs present parallel furrows running all through them, which separate in all from five to twelve lobes, and the cords of the siphon

tapering at the two extremities are also transversly furrowed, one might almost say crimped, as the furrows diminish or augment, according to the contraction or relaxing of the siphon. Injections, made for the purpose of discovering if

Luminous Organs of Pholades.

these organs have special vessels, led me to discover that an artery coming from the inferior aorta is directed to the triangular organs, but gives them no special ramification;

nevertheless the triangular organs receive their vessels as do the cords from the network of the capillaries of the internal part of the mantle. Investigations made with the object of discovering the nerves of these animals, assured me that from the branchial or inferior ganglion two trunks are given off, which afterwards constitute each two other little ganglions from which emanate the ramifications destined for the inferior portion of the mantle, as also others destined for the siphons; from each proceed very fine filaments which I have been able to follow as far as the triangular organs and cords.

Wishing now to speak of the structure of these organs, I may observe that sections made in every direction and treated by every different method of preparation, have led me to remark that they are only elevations formed of the subcuticular tissue of the derma, being on the surface covered by a special epithelium. This epithelium constitutes the small very superficial white coating of these organs, and this epithelium is worthy of a special description, since it produces the phosphorescent matter.

The Pholades, as also the analogous molluscs, are covered in their soft parts by an epithelium which is usually covered with cilia on the surface of the foot, the gills, and on the interior surface of the mantle, and of the siphons, and is cylindrical with a special cuticle on the edge of the mantle and on the external part of the siphons, which in the Pholades is also furnished with special papillæ. This epithelium does not exactly follow the surface of the organs, but introduces itself profoundly into the special furrows which resemble those which surround the cerebral convolutions, so that the epithelial surface is much larger than it at first appears, just as one also observes with the intestinal epithelium of many animals which have not enteric glands properly so called. The furrows which we have already observed in the triangular organs and even those seen across the cords have the same significations as the furrows which we have just mentioned; nevertheless, they are deeper and easier to see on account of the form of the organ.

The triangular organs and the cords since they form part of the interior portion of the mantle are then covered with a ciliated epithelium of the same form and of the same dimensions as that which covers the adjacent organs, but the contour of these cells is quite special. At first the nucleus of these cells presents a granular form, and these granulations project from the surface. This peculiarity of the nucleus extends usually over the whole contents of these cells, which also appear granular, so that their contours get

mixed, and it is not always easy to define them. These cells, far from resembling those of the ciliated epitheliums of the other parts, are fragile and easily allow their contents to escape. It is sufficient to touch with a glass slip the surface of one of these organs that has never before been touched, to see immediately a white matter attach, which shines and which under sufficient magnifying power is seen to be composed of granular nuclei, of very fine granulations, of small greasy drops, and even of granular masses which represent the entire contents of the cells of which they preserve the form. A fold of the epithelium of the same nature is that which renders luminous a band placed under the superior edge of the mantle; it is thus that is obtained the luminous arch before mentioned.

After having compared this epithelium with that of the phosporescent medusæ, and having pointed out the difference which exists as to the disposition and the form of the matter it contains, the phosphorescent organs are compared to those of Pyrosoma. In so far as that in these also the luminous organs are formed of cells which belong to the exterior coating. Nevertheless in the Pyrosoma these organs are very deep and their elements fixed, while in the pholades they are formed of elements placed on special and fragile outgrowths so that their product, as happens in a secretion, can be poured out externally.

The luminous matter contained in the cells of the luminous epithelium is soluble in alcohol and ether; and it would be very important for chemists to study it closely, so much the more so as it is easy to procure it where Pholades are abundant.

The second part of my work contains the results of experiments made on the entire animal and on the isolated luminous matter, and I also take note of the energetic action of soft distilled water employed both at 0° and at a very much higher temperature, as also the action of alcohol and ether which have the power of evoking the light, and in a few minutes extinguish it. The luminous matter was spread on a sheet of paper and then placed first in pure oxygen, and then in carbonic acid; neither in the first case did it shine more, nor in the second did it become extinguished, but remained the same, that is to say, it ceased little by little. This question has been treated by me in my work on the Pennatulæ. If the Pholades are exposed in air or in oxygen the light will continue for three or four days, or even more; while in carbonic acid, it becomes extinct in one hour, but if after its extinction one exposes it again to the open air the light

reappears. It is worthy of special mention that the luminous light of the Pholades in heated sea water lasts until 73°C., and sometimes attains 76° C. The action of electricity is not very powerful, and the effect of solar light in no way modifies the luminous power of the Pholades. Numerous experiments prove the great analogy of the phosphorescent matter of these molluscs with that of the animals we have already studied.

In the analysis of this light I find the spectroscope of Sorby and Browning applied to the microscope, which Mr. Ray Lankester had the kindness to offer me, useful beyond all others. This spectroscope, allowing two rays to pass through the same prism, has the advantage of having two contiguous spectra, one of the solar light, the other of the substance under examination. Having used gas light on this occasion it was necessary to make this light pass through a substance which would furnish lines of absorption of which the place was already known in respect to the solar lines. The substance used in this case was the solution of permanganate of potash, which gives five distinct lines. Things being thus arranged, we submitted to observation the triangular organs and the cords, employing ether to excite them. The light was very vivid for some minutes, so that one had full time to examine them. The light of the Pholades is monochromatic like that of the Beroes, of the Alcynoes, of the Ippopodiums, of the Medusæ, of the Eledones already observed. However, the azure band has a permanent place, and extends from line E to line F, passing the former by very little. It would be very important to observe if the band of light of other marine animals that are also monochromatic is found in the same place.

We will now give the entire conclusions this memoir arrives at; they are—

1. That in the *Pholas dactylus* are found special organs which give out light in certain particular cases, and which produce a luminous matter, which appears to be a secretion.

2. The organs are formed principally of ciliated epithelium, containing in its cells the special granular substance which renders the water luminous, and which mixes with the mucus which separates from the surface of the animal; this matter is soluble in alcohol and ether.

3. This epithelium in the above-mentioned species is found under the superior edge of the mantle, and in those organs which we have called triangular organs and cords.

4. The luminous matter of the phosphorescent epithelium escapes from these organs when the animal is submitted to

the action of stimulants. It is observed that the phosphorescent matter when extricated from the animal can be caused to become luminous by agitation, by the action of fresh water, of electricity, and of heat, as in the case of the luminous matter of the Pennatulæ, Medusæ, of Pyrosoma, and of other marine animals which are phosphorescent.

5. The same matter becomes luminous when moistened and agitated, even after it has been spread out and dried in the air, or even if the phosphorescent organs have been entirely dried without separating them from the mantle.

6. Air and oxygen excite and maintain the light of the Pholades for a long time during putrefaction; carbonic acid, on the contrary, extinguishes it. That air can re-illuminate it, whence one is led to believe that phosphorescence is a phenomenon which accompanies the oxidation of the luminous matter.

7. The light of Pholades is monochromatic like that of the Beroes, Alcynoes, Ippopodiums, of the Pelagia, and of the Eledones, and its band has a constant place in connection with the lines of the solar spectrum.

8. During the luminosity of the phosphorescent matter of the Pholades there is no development of heat which can be appreciated. This result has been arrived at after employing the most delicate instruments, to wit, those very same thermo-electric piles and the same galvanometer with which Melloni succeeded in determining the small amount of heat furnished by the lunar rays.

On the PRESENT CONDITION *of* ENGLISH OBJECT-GLASSES *as regards* DEFINING POWER. By Dr. G. W. ROYSTON-PIGOTT, M.A. Cantab., Fellow of the Cambridge Philosophical Society, the Royal Astronomical and Microscopical Society, Member of the Royal Institution, Royal College of Physicians, and late Fellow of St. Peter's College, Cambridge.

THE very considerable improvement that has taken place in the construction and performance of the best English glasses during the last two or three years leaves in the minds of many persons a conviction that nothing further need be done in this direction. Even three years ago Mr. Wenham pronounced them perfectly corrected; but the great advance made since that time has in some measure modified this opinion. Mr. Wenham's opinion was thus

expressed, 'Monthly Micro. Journal,' p. 302, 1870, in reply to the researches of the writer, on the residuary aberration of the microscope:—

"Objectives from the hands of careful and experienced makers have all been constructed on the globule test, and are not sent forth till every error of workmanship, centering state of oblique pencils, achromatism, and spherical aberration, *are all absolutely corrected* (*sic*, except the *italics*); for this discovers the least fault of either when all others fail."

Those who now enjoy the beautiful definition of first-class objectives remember with regret the innumerable labours they have thrown away in trying to see nature through a bad pair of spectacles, which often misrepresented and caricatured some precious object, and displayed nothing but false images of real structure. Curiously by one of the first axioms of Euclid, the Egyptian, a line was defined 300 B.C. to be an assemblage of points; but the microscope, which for a hundred years had shown lines until recently in many objects, failed to show the points of which the line was composed. Accordingly, the word "lined-object" has disappeared from the new *nomenclature* of the microscopist. When defining power was in its infancy, a wonderful diamond or sapphire doublet was prized for the *striæ* it could develop. I have in my possession a doublet, of Pritchard's make, of $\frac{1}{80}$th of an inch focal length, of very small angular aperture, which shows the *Podura* exclamation-markings on a test-scale (*P. curvicollis*).

This doublet, used as a condenser, develops a remarkably clear, pure, and beautiful miniature image of a brilliant flame. In the case containing this valuable relic of the past, there are about sixteen others, the defining power of which seems exactly measured by the precision of the brilliant image miniatured by them when examined by a first-rate microscope.

Now, if for this doublet a fine $\frac{1}{8}$th immersion be substituted, and the microscope be armed also with a fine $\frac{1}{8}$th or $\frac{1}{16}$th immersion lens, so that the miniature be formed within the substance of the drop of immersion fluid, using a low eyepiece, all the deviations of the miniature, from what we know ought to be the appearance of the miniature, can at once be determined.

A great variety of effects will be discovered by slightly altering the screw collars of the miniature forming- and observing-object-glasses. A small brilliant flame, or glittering object, or a distant table lit up by daylight or sunbeams, the microscope being placed horizontally, so as to form the

miniature landscape within the drop of water, or even glass rods crossed, forming distorting lenses and curious images when illuminated from behind, or a thousand other contrivances, may all be used to display the state of the magnified miniature.

In this manner I had the good fortune to detect a strong yellow fog in a $\frac{1}{8}$th objective[1]—pronounced very fine by Messrs. Powell and Lealand—which had escaped their detection by the ordinary tests employed by those excellent makers, now unsurpassed throughout America and the continent.

The very trying and fatiguing labours of these makers to diminish the residuary errors of their glasses, so soon as pointed out, have been rewarded with unprecedented success. The introduction of a saturated solution of the ammonio-sulphate of copper, as destructive of the red and yellow rays of the solar spectrum, and producing a blue ray sufficiently monochromatic to eliminate the aberration of the yellow-red rays, has been recently crowned with a most gratifying success. Under these circumstances, what is so difficult to *see* with compound light is photographed *actinically* with an unaberrating ray. I had the honour of exhibiting, at the *soirée* of the Royal Society this year, a series of photographs presented to me by Colonel Dr. Woodward, in which the $\frac{1}{16}$th immersion had depicted, by means of the blue ray, the beaded structure of the *Podura Degeeria* and *P. curvicollis* test-scale in the greatest perfection. This glass is the only one that ever succeeded in photographing Nobert's band 19, containing 112,000 lines per inch. These results teach us that to see an object in its purity and integrity under very high powers requires the use of contrivances for eliminating the residuary aberration. This is done by Colonel Woodward's plan to a certain extent, and also by the "searcher for aplanatic images" much used by the writer.

But there is another point which is a very rife cause of disagreement amongst observers while using high powers, viz. what is the true focal plane of vision? one professing this and another that. A most striking example of this is that the Podura markings, as usually seen, are shadows produced by the crossing of two different sets of structures on different planes, and that the upper beading is seen on a plane above what is usually focussed for.

Another cause of wrong observation and interpretation is, the observer and maker spherically under-correcting the objective at the time of observation. Messrs. Powell and Lealand, for instance, frankly admit that they cannot see the Podura markings well on their best scales, except their

[1] 'Phil. Trans.,' vol. ii, 1870, pages 592-3.

glasses are spherically under-corrected !! I have long maintained the opinion that the glassesare purposely made to show a certain standard effect, which effect is itself a delusion.

But it is evident that when a miniature at the proper distance is found to be a precise, clear, and effective portraiture of the reality, and bears large amplification with the utmost satisfaction and clearness, that all doubt as to the goodness of the glass is at once dispelled.

If we ask the photograper the simple question—Will your glass form with equal precision either a miniature of an object or an enlargement of a small object? he will reply, that depends upon the quality of the glass, but that a perfect glass ought to do both for the distance at which it has been corrected. It is surely just the same thing with the system I have now been some time patiently advocating, viz. the miniature test, enlarging it by the microscope. *The goodness of the glasses is proclaimed by the agreement of the enlarged miniature with the object miniatured.*

The advanced photographer experiences none of those bewildering stumbling-blocks in general which beset the path of the high-power microscopist, simply because he knows at once whether his miniature resembles nature. If the foreground and distance of a landscape is accurately and delicately delineated on his plate, all in focus and without distortion, he can pronounce the result superb at once. He goes in general from the large to the minute. He can always test his result by his known chosen object, every detail of which he can examine and compare with his picture.

But with the microscope all is changed ; the eye is indeed photographing on the retina, as well as it can, the image of, perhaps, an utterly unknown structure. We have no means here of comparing the picture with the original. But if a fine image one thousand times smaller will bear re-amplification one thousand times, and reproduce the details of the known original, the standard of correspondence, as in photography, is at once rehabilitated. Still worse is it for the observer with a preconceived notion of structure that he cannot cast off the tyrant idea overriding his better judgment, even, perhaps, against his will.

The speculations on structure warmly disseminated during the last twenty years will probably cause the microscopists of the rising generation to compassionately smile upon the credulity of their forefathers.

I propose now to touch upon a few points connected with the defining power of high-class objectives, which, I trust, may not be uninteresting.

Many high-class objectives are carelessly condemned, or at least disparaged, from the following causes:

(1) *They are applied to a body which is either too long or too short.*

Thus, nearly all the continental objectives, dry or immersion, are corrected for about six inches, and even five. Immense advantage will be gained by using a *telescopic* body capable of being shortened or lengthened at will, in order to *search* the *axis* for the most perfect "aristokratic image"[1] which the objective is capable of forming, when it will be found, with proper screw-collar adjustments, that a new power of high-class definition and amplification will be gained in many unexpected cases.

(2) Further, there is a certain thickness of covering glass and a certain refractive index for it which, par excellence, gives the finest effects.

(3) And, again, as a variation of the length of the body necessárily causes also the distance of the objective from its object to vary, great changes are thus made in the optical conditions of vision.

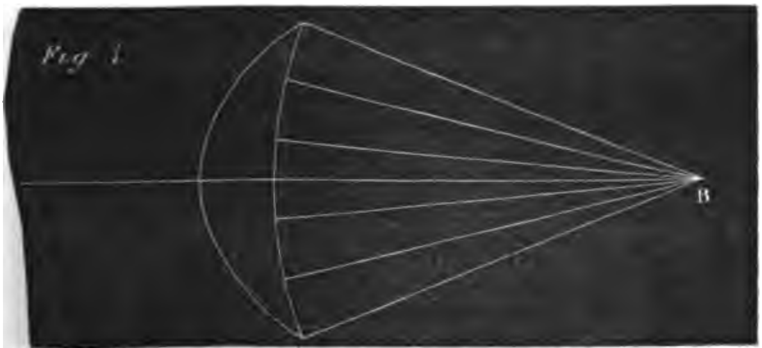
Thus, the thickness of the stratum of air in the dry lens is increased as the body is shortened and the course of the rays is changed, the achromatism alters, and the spherical aberration takes a new form; whilst in the water lens a greater thickness of water film also materially changes the definition.[2] On the other hand, a greater or less thicknesss of covering glass causes a less or greater thickness of water film, and this changes the character of the definition. In the beautiful 1-8th and 1-16th immersion lenses now made, these effects are very evident to a careful observer. Indeed, there seems to be an absolute necessity of attending to the degree of thickness of the cover in producing the very finest effects of which a given objective is capable of developing, the screw collar being after all, as I have before stated, but a rough compensation for variable thickness, good enough for the tests employed at the time of its invention.

I have not as yet been able to induce any of my friends to venture upon the infallible test of objectives described by me in the 'Philosophical Transactions.' The process is regarded as difficult and dangerous, as bringing the observing and image-forming objective into a dangerous proximity. Still, revelations are made in this way obtainable by no other method.

[1] The term "aristokratic image" was introduced to denote the *best power image* obtainable by given combinations of eye-pieces, searcher and objective.

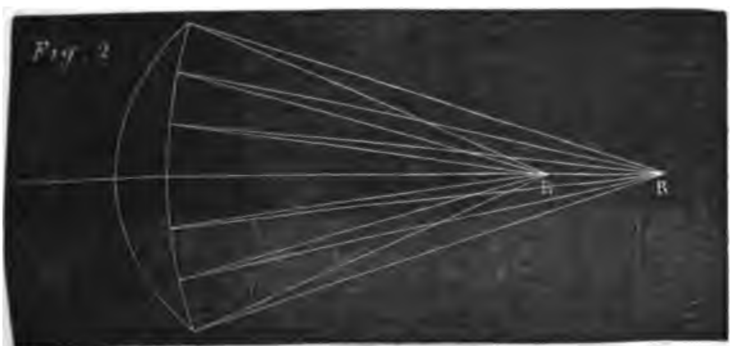
[2] Messrs. Powell and Lealand fully agree with me in this view.

Example.—In the finest objectives now obtainable I find when the spherical aberration is corrected there is a strong secondary spectrum, chiefly consisting of a mixture of the red and yellow rays. But when this is corrected, by using all possible precautions, so as to render the achromatism almost absolutely perfect, *then the aberration reappears.* In point of optical fact the focal point where the spherical aberration vanishes does not correspond with, or is not identical with, the focal point where the coloured rays are blended into white light. But as all the makers more readily detect imperfect achromatism than residuary aberration, the latter is sacrificed to the former. All the glasses with which I am acquainted err in this respect.



This important point may appear somewhat more intelligible by referring to figs. 1 and 2.

In fig. 1 all the rays of every colour are supposed to be ultimately united at the point B, the rays being supposed to be forming a miniature point at B; aberration, spherical and chromatic, are both destroyed.



In fig. 2, on the contrary, the red rays are cutting the

axis at a point distinct from B. The great bulk of the rays, except the red or reddish yellow, converge accurately to B, whilst the residuary rays of reddish yellow converge to R, so that we either in general get achromatism with residuary spherical aberration, or reddish-yellow rays when the spherical aberration is destroyed. In other words, the achromatic focus and the aplanatic are not identical.

Spherical aberration, as detected by the methods I have recommended, displays itself in a colourless milkiness or whitish smoke-like cloudiness. Dissipate this by better spherical corrections, and it is immediately replaced by all brilliant points becoming irradiated with the orange-red halo.

The obstinacy with which the false Podura markings are adhered to in correcting glasses almost necessitates a wrongly corrected spherical aberration. These markings cannot be seen except the upper beads be focussed through.

If the orange-red rays be absorbed by the ammonio-sulphate-of-copper solution transmitting monochromatic light, definition actinically is much more easily produced. But the eye receiving ordinary compound light, whilst the spherical aberration is neglected to the advantage of the achromatism, cannot possibly see as well as the actinic monochromatic rays potentially define and depict. A point may be ascertained in the axis where the aberration may be almost extinguished, when it is no longer confused with uncorrected red and yellow rays. In other words, the blue rays may be brought accurately to the same mathematical point in the axis, whilst all others would vary more or less or aberrate.

The mathematical conditions of the least possible colour are improved by these changes :—

1. Varieties of position of the lenses.
2. Varieties of refractive indices in the glasses employed.
3. Varieties in actual focal lengths.
4. Varieties in the immersion fluids.
5. Variety in the nature and thickness of the glass cover.

In many cases more delicate adjustments can be made by changing the distance between the back or larger combinations of the objective. The combinations for producing the best glasses are endless, like those of an extensive peal of bells.

In the *colour test* (described by the writer in a paper sent to the Royal Microscopical Society, May 21, 1869, page 302, December number of 'Journal'), the phenomenon of the very finest definition obtainable by the very best objectives then made, presented to me very considerable difficulties for explanation, which I was not then able to grapple with. More recent experiments, carried on with objects

miniatured on the stage, when lit up with direct sunlight, have put me in possession of this general and important fact, that as yet careful destruction of spherical aberration develops colour in all the best glasses. Colonel Woodward, of Washington, who has most handsomely placed at my disposal a series of photographs taken by the actinic rays, of monochromatic sunlight, has frequently confirmed my original statement as regards the colour test, as also in the last number of the 'Lens' published at Chicago.

The colour test was thus described by the writer:

"I cannot too strongly call attention to the beautiful phenomenon, which I have always endeavoured to obtain as a fine and reliable test of approaching aplanatism, and heralding a fine definition. In examining striated bodies, longitudinal bands glisten with a ruby tint upon a green or yellowish ground; the bands appear like pellucid, semitransparent, cylindrical ribs, and the flashing of these bodies with a ruby glow is a signal, in my experience, that the aberration approaches a minimum; when the beading dispels the mist and haze always accompanying the spurious spines."—Page 302, 'Monthly Micro. Journal,' December, 1869.

Again, in the April number of the same journal, 1870, I remarked:

"I have lately seen the Formosum beading coloured with red, orange yellow, and blue. The beading has appeared wreathed with a golden bronzing; individual beads, separated from their fellows, appeared remarkably distinct. Destruction of colour reduces the field to a spiritless picture. Objects which can be, and in many cases are, lit up with a startling brilliance of hue regain, with altered corrections, the tame colouring of a dull prevailing yellow and black. There is something recondite here beyond our ken."—Page 193.

If we view diatoms in sunlight, *en masse*, by the unaided sight, they appear to disperse their rays with a rich prismatic beauty, the colours constantly varying with a change of position:

"Yet these colours, so evident to the unassisted eye *en masse*, vanish in *achromatic vision*; should these charming colours be destroyed?"—Page 193.

These appearances are full of a significant interest; still I have constantly been able to see the most perfect definition of minute markings only when I had *disturbed the achromatism* insisted upon by the makers of the glasses. Whenever I had so adjusted these glasses that the field was as perfectly achromatic as possible, then the minutest structures formerly visible, *with colour*, vanished.

The conclusion to be deduced from these facts is this: that

achromatism is obtained by the sacrifice of perfect aplanatism. When the spherical aberration is nearly destroyed, in all the glasses I have been able to examine during the last ten years, then the *colour* is increased or achromatism is destroyed; in a word, the most perfect definition of close points is seen with colour; the colour and their definition vanish together. It is an exceedingly difficult task to demonstrate this on paper without apparatus in operation.

One other cause of imperfection in high-class objectives is, the slight deviation of the centres of the various lenses from the axial line. A brilliant point of light, imaged upon the stage in the manner already described, and viewed by an objective thus damaged by imperfect centering, displays an immense quantity of intersecting circles, precisely resembling the back of an engine-turned watch; and the greater the number of the uncentered lenses the more complicated becomes the pattern.

(*To be continued.*)

On the DIFFERENCES *between the* NOMINAL *and* SOLAR FOCAL LENGTH *of* ENGLISH OBJECT-GLASSES. By DR. ROYSTON-PIGOTT, M.A., &c., &c.

OUR English opticians have been somewhat hardly accused of pretending, for trade purposes, that the focal length of their object-glasses is misrepresented, and that they are really of a much deeper character than the name they bear.

Fortunately, with very little calculation, the honesty of these nominal foci can be readily established. I have shown ('Phil. Transactions,' p. 594, vol. ii, 1870) that if

d be the distance between an object and its image formed by an equivalent lens,

m the number of times it is magnified,

f the focal length of the lens for parallel rays or solar focal length; then

$$f = \frac{d}{m + 2 + \frac{1}{m}};$$

if m be very large, $\frac{1}{m}$ is so small that it may be neglected, and then

$$f = \frac{d}{m + 2}.$$

But when m is small, $\frac{1}{m}$ must be retained. For those unacquainted with this kind of notation, it may be stated in

plain English thus:—The solar focal length, when a small lens is used and the image is greatly magnified, by dividing the distance between the object and image by the number of times the object is magnified, increased by 2.

Example.—Suppose a screen is 100 inches from an object, which is found by measurement to be magnified upon the screen 60 times: what is the focal length (solar) of the lens?

$$f = \frac{100}{60 + 2} \text{ nearly} = 100 \div 62 = 1{\cdot}6129.$$

If greater accuracy is required, the divisor must be increased by $\frac{1}{m}$, or $\frac{1}{60}$.

Thus,

$$f = \frac{100}{60 + 2 + \frac{1}{60}} = \frac{100}{62{\cdot}016667} = 1{\cdot}61247.$$

The first approximation is true to three places of decimals.

The converse property is also easily ascertained when the image is considerably enlarged. Suppose the focal length is known, and it is required to find the magnifying power at a distance (d), then

$$m = \frac{d}{f} - 2.$$

('Phil. Transact., p. 594, 1870.)

Example; $f = 2$ inches: what will be the magnifying power at 180 inches' distance of screen from object?

$$m = \frac{180}{2} - 2 = 90 - 2 = 88 \text{ nearly}.$$

If it be required more accurately, then the quadratic equation

$$m + 2 + \frac{1}{m} = \frac{d}{f}$$

must be solved; or,

$$m^2 + 2m + 1 = \frac{md}{f};$$

or,

$$m^2 - \left(\frac{d}{f} - 2\right)m = \quad -1;$$

or,

$$m = \tfrac{1}{2}\left(\frac{d}{f} - 2\right) \pm \sqrt{\tfrac{1}{4}\left(\frac{d}{f} - 2\right)^2 - 1}.$$ [1]

The focal length of a very small single lens is rather difficult of measurement, as the refractive index as well as the curvatures or radii of surfaces require to be accurately known.

[1] The positive sign must be taken, and the distance between object and image cannot be less than four times the focal length, and then m has a *minimum* value.

If, however, a small central aperture be formed by a stop, and any convenient distance be taken between the object and image (micrometric lines are the best to measure), the focal length can be easily found by the formula above quoted.

Example.—I have a Pritchard doublet, magnifying 180 times at 8 inches: what is the focal length?

$$f = \frac{d}{m+2} = \frac{8}{180+2} = \frac{8}{182} = \frac{4}{91}.$$

Having illustrated the use of this formula in as simple a manner as practicable, it is now requisite to settle upon what principle nominal focal lengths are to be ascertained. Evidently the first thing to be done is to agree upon the standard of reference. No better, I take it, can be adopted than a uniform distance between the object and magnified image of ten inches. This image may be viewed by using the microscrope as a miniature-enlarging camera, be received on ground glass, or it may be viewed as a virtual image formed within the stop of the eye-piece, the field glass being removed, either received there upon a glass micrometer or upon thin oiled paper graduated finely or carefully measured by the camera lucida.

Let us take the example of an ordinary one-inch objective as now made. If the tables be examined printed by different opticians, it will be found that with a C eye-piece in general this power is given as 100 diameters. Now, the C eye-piece magnifies ten times, and if all the glasses be removed from it there will be found a certain length of tube for the body of the microscope, where, within the stop, an image will be found to be exactly magnified ten times. This point should be exactly ten inches' distance from the object. In different glasses this distance will be found to vary slightly, but in the main it is ten inches, neither more nor less. If now, an eye-lens of exactly one inch focal length, *i.e.* magnifying ten times, be inserted within the empty eye-piece, so that the stop shall be precisely in focus, then the magnifying power at this standard distance will be 100.

Now, let us calculate what the focal length (f) of an equivalent lens would be to magnify an object ten times upon a screen placed ten inches from the object.

Now, if m be large, $\frac{1}{m}$ may be neglected; but in the case of the inch m only equals 10.

$$f \text{ really then} = \frac{d}{m+2+\frac{1}{m}} = \frac{10}{10+2+\frac{1}{10}}$$

$$= \frac{10}{12 \cdot 1}$$
$$= \cdot 826446,$$

so that the maker, in producing an "inch" objective capable of forming an image one hundred times larger with a C eye-piece at 10 inches' distance, must form it of a solar focal length of

$$0 \cdot 826446,$$

or nearly $\frac{1}{5}$th of an inch less than one inch.

But as the powers increase, and the focal length diminishes, the solar focal length more and more nearly approaches the nominal.

Example 2.—"One half inch," magnifying 200 with C eye-piece at 10 inches' distance:

$$f = \frac{d}{m + 2 + \frac{1}{m}} = \frac{10}{20 + 2 + \frac{1}{20}}$$
$$= \frac{10}{22 \cdot 05}$$
$$= 0 \cdot 453514,$$

focal length of "half inch" *nominal.*

If the first approximation be taken, leaving out $\frac{1}{m}$

$$f_1 = \frac{d}{m+2} = \frac{10}{22} = \frac{5}{11} \left(\text{nearly } = \frac{5}{10} \text{ or } \frac{1}{2}\right)$$
$$= 0 \cdot 545454$$

Error, $\frac{1}{10}$th of an inch.

Example 3.—"One sixteenth:" *nominal power* 1600: C eye-piece; $m = 160$.

$$f_1 = \frac{d}{m+2} = \frac{10}{160+2} = \frac{10}{162}$$
$$= \cdot 0617284$$
$$\tfrac{1}{16}\text{th} = \cdot 0625000$$
$$\text{Difference} = \cdot 0017716$$

or, say, $\frac{18}{10000}$ths of an inch.

A nearer approximation will be obtained by not neglecting $\frac{1}{m}$ or $\frac{1}{160}$, when

$$f = \frac{10}{160 + 2 + \frac{1}{160}} = \frac{10}{162 \cdot 00625}$$

$$= \cdot 0624975$$
$$f_1 = \cdot 0617284$$
$$\overline{\cdot 0007691}$$

Error, $\frac{77}{1000000}$ths, or $\cdot 00077$.

$$f = \cdot 0624975$$
$$\tfrac{1}{16}\text{th} = \cdot 0625000$$
$$\text{Difference} = \cdot 0000025$$

between $\frac{1}{16}$th the actual focal length and the nominal $\frac{1}{16}$th, which amounts to an almost inappreciable quantity of $\frac{25}{100000000}$ths of an inch. No English maker could possibly make a $\frac{1}{16}$th object-glass which magnifies 1600 times with a C eye-piece at 10 inches more accurately than this standard.

Example 4.—"One-eighth" *nominal.*

$$f = \frac{10}{80 + 2 + \frac{1}{80}} = \frac{10}{82 \cdot 0125}$$
$$= 0 \cdot 12193263$$
$$\tfrac{1}{8}\text{th} = 0 \cdot 12500000$$
$$\text{Difference} = 0 \cdot 00306737$$

or $\frac{3}{1000}$ths of an inch.

But, if we take a "two-inch" or "three-inch," then the focal length is considerably shorter than the nominal, as the conjugate focus is more widely separated from the solar for parallel rays.

Example 5.—"Two-inch:" magnifying power 50 at 10 inches, and 5 without the C eye-piece.

$$f = \frac{10}{5 + 2 + \frac{1}{5}} = \frac{d}{m + 2 + \frac{1}{m}}$$
$$= \frac{10}{9 \cdot 2}$$
$$= 1 \cdot 42857.$$

Which is less than $1\frac{1}{2}$ inch.

Résumé.

Nominal objective.		Solar focal length for parallel rays.	
2-inch	. .	$1\frac{1}{2}$ inch, less	$\frac{7}{100}$ths.
1 ,,	. .	1 ,,	$\frac{17}{100}$ths.
$\frac{1}{2}$,,	. .	$\frac{1}{2}$,,	$\frac{56}{1000}$ths.
$\frac{1}{8}$,,	. .	$\frac{1}{8}$,,	$\frac{3}{1000}$ths.
$\frac{1}{16}$,,	. .	$\frac{1}{16}$,,	$\frac{3}{10000000}$ths.

On a Method *of* Finding *the* Refractive Index *of* Glass *by* Means *of the* Microscope *and* White Light.

By G. W. Royston-Pigott, M.A., M.D. Cantab., F.C.P.S., M.R.C.P., F.R.A.S., M.R.I.

The following method has occurred to me whilst writing these papers:

If d be the distance between an object (as micrometer lines, placed on the stage) and the image formed, f the focal length of the lens, and m the magnifying power at the distance d, then ('Phil. Trans.,' p. 594, vol. ii, 1870) I have shown

$$f = \frac{d}{m + 2 + \frac{1}{m}}$$

Suppose now, in order to obtain a very distinct image at a distance from the object of 10 inches, a glass lens, fastened to the nose of the microscope, be stopped off, so as to leave a small central aperture, then, provided the curvature of the lens is known (which, indeed, can be worked to any radius), and the lens be very thin,

$$\frac{1}{f} = (\mu - 1)\left(\frac{1}{r} + \frac{1}{s}\right)$$

for double convex; or,

$$\mu - 1 = \frac{rs}{r+s} \cdot \frac{1}{f} \quad \text{(A)}$$

$$= \frac{rs}{r+s} \cdot \frac{m + 2 + \frac{1}{m}}{d}$$

or the refractive index, diminished by unity, is equal to the products of two results, viz.:

1. The product of the radii of the lens, divided by their sum.

2. The reciprocal of the focal length, or unity divided by the focal length.

If the lens be plano-convex, the first quantity is reduced to *half the radius: if the plane side be turned to the object.*

Example.—A crossed lens, having two radii respectively, of 1 inch and 6 inches, is fixed on the microscope; so that an image of the micrometer is observed with a pocket lens to be magnified (at a distance of 12 inches) exactly 6¼ times, a small central aperture being used: find the refractive index

of the glass. The focal length may be approximately determined thus:

$$f = \frac{d}{m + 2 + \frac{1}{m}} = \frac{12}{6\frac{1}{2} + 2 + \frac{1}{6\frac{1}{2}}} = \frac{12}{8\frac{1}{2} + \frac{2}{13}}$$

$$= 1{\cdot}38666.$$

Also,
$$\frac{rs}{r+s} = \frac{1 \times 6}{1+6} = \frac{6}{7}.$$

Then,
$$\mu - 1 = \frac{6}{7} \times \frac{1}{1{\cdot}38666}$$
$$= {\cdot}61813;$$

and
$$\mu = 1{\cdot}61813,$$

the refractive index.

A further correction may be added for thickness, as follows:

If t be the thickness of the lens at the centre, s the radius of the surface next the object on the stage, r the radius of the surface next the eye, the approximate focal length must be increased by[1]

$$\left(\frac{\mu-1}{r}\right)^2 \cdot \frac{t}{\mu} f^2.$$

In the case before us of the crossed lens, supposing the more convex surface be placed next the object $r = 1$, $\mu - 1 = 0{\cdot}61813$, and if we suppose the lens to be $\frac{1}{10}$th of an inch thick, $t = 0{\cdot}1$, and the correction for increasing f, which nearly $= 1{\cdot}38666$,

$$= \frac{\overline{0{\cdot}61813}|^2}{1} \times \frac{0{\cdot}1}{1{\cdot}61813} \times \overline{1{\cdot}38666}|^2.$$

which, reduced, $= 0{\cdot}0382085 \times 1{\cdot}922853 \div 1{\cdot}61813$
$= 1{\cdot}188318 \times 0{\cdot}382085$
$= {\cdot}0454038$

but f $= 1{\cdot}3866666$

f' then $= 1{\cdot}4320704 = 1{\cdot}43207.$

Hence,

$$\mu - 1 \text{ now} = \frac{rs}{r+s} \times \frac{1}{f} = \frac{6}{7} \times \frac{1}{1{\cdot}43207} = 0{\cdot}59853.$$

The error by neglecting thickness amounts to the difference between the two values of μ, viz.—

$$\begin{array}{r} 1{\cdot}61813 \\ 1{\cdot}59853 \\ \hline 0{\cdot}01960 \end{array}$$

[1] It is remarkable that the correction for the thickness does not depend at all upon the radius of the surface next the object, but only upon the radius of the surface furthest from the object.

But if the flatter side of the lens be placed nearer the object, then $r = 6$, and as the correction varies inversely as the square of r or 36, the correction will be 36 times smaller for the refractive index, and consequently $= 0{\cdot}0196 \div 36 = 0{\cdot}00054$. A thickness of $\frac{1}{10}$th of an inch in this case only changes the value of the refractive index calculated in this way by a decimal in the fourth place.

Here,

Approximate value of μ	$= 1{\cdot}61813$
Correction for $\frac{1}{10}$th thickness	$= 0{\cdot}00054$
Corrected value of μ	$= 1{\cdot}61759$
Or refractive index corrected	$= 1{\cdot}6176$ nearly.

On the Circulation *of the* Blood *in* Pyrosoma, *especially as observed in the* Embryo. By P. Pavesi, Assistant to the Professor of Comparative Anatomy in the University of Naples. (With Plate XII.)

At the commencement of last winter I was occupied in studying the very interesting phenomena of the alternating current of circulation in the Salpæ, when several living examples of Pyrosoma (*P. giganteum*, Sav.), caught in the bay, were brought to the Laboratory of Comparative Anatomy for the researches on phosphorescence, which Professor Panceri continues to prosecute with such important results.

It is well known that M. Milne-Edwards was the first[1] to announce that the Ascidians of this celebrated animal are provided with a heart analogous to that of the other Tunicates, and that it reverses similarly periodically the direction of its movements. This discovery has been more recently confirmed by Professor Huxley[2] and by MM. Keferstein and Ehlers.[3] It was, therefore, natural that I should turn my attention at once to this point, and since I have been fortunate enough to discover some new facts with regard to it, following the request of Professor Panceri and Dr. Krohn, of

[1] "Sur la circulation du sang chez les Pyrosomes," 'Annales des Sc. Nat.,' iii sér., t. xii; 'Zool.,' 1839; 'Comptes Rendus,' t. x, 1840; 'Institut.,' viii, année vi, 321, 20 Février, 1840; 'Observations sur les Ascidies composées des côtes de la Manche,' Paris, 1841, p. 13.

[2] "Observations upon the Anatomy and Physiology of Salpa and Pyrosoma," 'Phil. Trans.,' 1854.

[3] 'Zoologische Beiträge,' Neapel u. Messina, 1861.

Bonn, who is now in Naples, I make them the subject of this note.

The season (December and January) was favorable for studying, besides the circulation in the adult Ascidians, the mode of circulation and nutrition in the embryos, which had not yet been observed. I intend chiefly to speak of the *compound embryos* discovered by M. Savigny,[1] better studied by Professor Huxley,[2] and lately by M. Kowalewsky.[3] It is established that from the ripe egg, after a partial segmentation of the vitellus, there appears an incompletely organized embryo, the so-called "cap" or cyathozooid of Professor Huxley, which gives rise by gemmation to four other zooids (ascidiozooids of Huxley); these latter enlarge, develope, and surround the cyathozooid, which at first is much larger than they are, but diminishes, and finally disappears at a later stage. The four embryos are united to one another, and to the cyathozooid, by means of a cord. This cord is attached to the cyathozooid, and passes, after a short interval, to the nearest embryo, attaching itself a very little below the ganglion; but it recommences at the other surface of the same embryo, and passes from the lower end of the endostyle to the ganglion of the neighbouring embryo, and thus is continued through the series to the last embryo, which has but a single connection. This cord, so well described by Professor Huxley, has been, perhaps, seen also by M. Savigny, since he draws in one of his figures a very short cord, of a V shape, indistinctly, which unites the four embryos, but he makes no mention of it in the memoir and in the explanation of the plates.

M. Kowalewsky has pointed out that a heart exists in the cyathozooid, which, in fact, is nothing else but a "nurse," similar to the generating larvæ of many inferior animals.

I have observed, in examining this heart of the "nurse," that it has the appearance of a tube, is very transparent, and that it may be seen in process of development lying in a more spacious cavity than itself, having definite walls like a pericardium, elongated, and broadened at the extremities. The heart is attached to this pericardium over one entire surface, but is free in the rest of its extent. It is placed obliquely a very little below the external layer of the "nurse," that is to say, quite superficially, in such a way that it may sometimes be seen, when the nurse is turned on its side, at the edge, or

[1] 'Mémoirs sur les Animaux sans vertèbres,' ii part, ii mém., 1816.

[2] "On the Development of Pyrosoma," 'Annals and Magazine of Nat. History,' 1860, January.

[3] 'Entwickelungsgeschichte der Pyrosoma,' Göttinger Nachrichten, 1868, p. 401. Confer. 'Archiv f. Naturg.,' 1869, p. 103, Bericht d. Mollusken.

if by pressure or accident the contents of the nurse happen to escape, the heart may remain attached to the internal surface of the external layer, as I have chanced to see it.

In this case the whole presents a very irregular aspect, similar to that which has been figured by Professor Vogt.[1] More strictly, this heart is placed in the space between the external and internal tunics of the nurse, which space I shall term "the peripheral sinus." The heart beats vigorously; indeed, it is almost impossible to see it when it is not beating. The pulsations are similar to those of the heart of the Salpæ, Ascidians in general, and of the adult Pyrosoma; that is to say, the heart begins with a movement of considerable energy at one of its extremities, which extends in a continuous undulation throughout its length; the movement is, in fact, peristaltic, like that of the intestine of the higher animals.

Scarcely is a complete pulsation finished when a second commences, then a third, and so on. But after 37, 39, 40, or 50 of these pulsations, the last of which are very uncertain, the heart makes a brief pause, and then recommences; but now the movement is changed, the direction of the contraction is reversed.

This heart has an importance and a signification greater than might be supposed, since from it the cord takes its origin which unites the four embryos; and since I have seen that the latter is vascular, the heart appears to be the centre of a "social" vascular apparatus common to all the embryos and to the nurse.

From the extract from Professor Huxley's memoir, which is all I have been able to consult, it is not possible to tell if he considered the cord to be a canal open at its ends, when he says that the primitive cord of the blastoderm, which unites the embryos, becomes converted at last into "a long canal." It is, however, certain that he would not have made out this canal to be vascular, because he studied the matter in specimens of Pyrosoma preserved in alcohol. But it is, in fact, so, and is, moreover, composed of two contiguous and parallel vessels, one of which arises directly from the heart, whilst the other communicates with the peripheral sinus of the nurse, and then forms a system of blood-vessels in the embryos by giving origin to branches.

In this way I was led to inquire into the origin and distribution of this vascular system.

In the first stage of the development of the embryos, that

[1] "Recherches sur les Animaux infér. de la Méditerranée,' 1853, ii mém., tab. x, fig. 10.

is to say, immediately after the nurse has developed them by gemmation, and whilst they are placed on its surface like a ribbon, which bears indications of a division into four pieces, there appears on each side of a continuous and regular band, which is placed in the middle line, and is their endostyle, a very fine canal, which runs throughout their length, and, arriving at the extremity, disappears under the endostyle and joins its fellow of the other side, constituting thus a true vascular loop.

These small vascular canals present in their course a varying diameter, and are pinched or enlarged in correspondence with the constrictions and dilatations which indicate the rudimentary embryos.

The maximum diameter is a little greater than that of the walls of the embryos themselves. The extremities of the vascular loop continue beyond the chain of embryos to a knob on the nurse formed of vitelline granules. This is the point at which the heart is formed a little later.

I have not been able to observe the actual development of the heart, nor to see it until the little embryos reveal their branchiæ, under the form of transverse elements. Then it makes its appearance a little below the buccal aperture of the nurse, like a little tube, somewhat long, directed obliquely towards that part where the embryos are placed; by its pulsations it forces the vitelline globules to them.

Since I have observed this fact in a thick section of Pyrosoma, which was in consequence not very transparent; and, moreover, since after a little time the pulsations of the heart ceased, I was not able to follow well the course of the globules in the embryos; but they could not flow otherwise than into vascular loop already described. When the embryos present already the ganglion, the mouth, the branchiæ with their longitudinal and transverse elements, and begin to separate themselves a little one from another and from the nurse, that is to say, in the successive and later stages of development of the entire system, that cord which I spoke about begins to become manifest, and one can see very well that it is composed of two parallel and contiguous vessels. It is easy, then, to understand that this cord originates in the vascular loop of the rudimentary embryos, which by enlarging little by little, and separating by degrees, allow the two vessels to be seen in the intermediate space, thus presenting the appearance of a connecting cord.

The cord continues in the interior of the embryos, and there is formed a circle, which can be recognised by the rapid current of the blood-globules; but it is easier to follow

its course in those embryos which have attained a higher degree of development, as in this case one can clearly see the peripheral sinus of the nurse. One of the vessels of the cord—that which is directly continuous with the heart—after a course of some length, is attached to the first embryo just a little below the ganglion; it penetrates the external tunic, and is directed to the mouth; is gently curved to the left, and then continues to the endostyle; it then passes below this, and descends with it to its extremity on the opposite surface of the embryo. Here it breaks up into two parts, one of which passes out of the external tunic, and forms one of the vessels of the cord, which unites the first embryo to the second; and the other, continuing its course in the first embryo, arrives on the neural surface; it passes out of the external tunic near the ganglion, and becomes united to that vessel, which came from the nurse, accompanies it in its course, and opens into the peripheral sinus. This vessel of the cord, which was given off from the first embryo, at the end of the endostyle, arrives at the second, penetrates the external tunic below the ganglion, and forms similarly a circle, having first given off near the inferior extremity of the endostyle a vessel to the third embryo, and to the first the other vessel of the cord which unites the two. In the third embryo there is the same distribution of vessels, except that, as in the second, there is an illusive change of aspect; and it is difficult to follow them, on account of their lying in different planes. At last the cord arrives at the fourth embryo, situated in the same plane as the first, and in this also the vessels follow the same disposition, but at the end of the endostyle the circle is closed; thus, the single original vascular loop of the rudiments of the embryos, when further developed, constitutes the entire vascular system.

It is a very interesting spectacle to follow with the microscope the rapid circulation of the blood in the entire system of the embryos. The heart of the nurse beats, pushes the blood into the first embryo by means of that vessel of the cord with which it communicates; the blood, after having here made a complete round, returns to the nurse, and is emptied into the peripheral sinus by means of the other vessels of the cord. The same pulsations of the heart draw the blood from this latter vessel, and oblige it to circulate in the peripheral sinus and to enter anew the heart by its open extremity. Since the heart closes the space between the internal and external strata of the nurse, the blood cannot pass in that direction, and must make the round; but the greater part of the blood passes from the first to the second embryo,

and here also circulates, and then returns to the first and afterwards to the nurse; in the same manner it circulates in the third and in the fourth embryos, thus constituting the general current. Thus, the same phenomena repeat themselves for a certain time, but the heart stops, and then reverses the direction of its pulsations; then, in place of commencing its movements from the portion which I shall call "auricular"—*i. e.* the open extremity—it commences from the portion which I shall call "ventricular;" and thus the vessel that communicates with the heart is changed from an artery into a vein, and the current is reversed in all the vessels of the embryos. By taking great pains I have succeeded in watching the circulation of the embryos during several hours successively, changing frequently the drop of water in which they were placed.

Mr. Huxley refers the nutrition to the contents of the ovisac, which, he says expressly, "must serve as a great reservoir of material for the developing embryo after birth;" and he adds, immediately afterwards, "the contents of the ovisac, therefore, though neither a food-yolk nor a placenta, serve the purpose of both." From what I have stated, it is clear that the nutrition of the embryos takes place, on the contrary, through the nurse; and it is so true that it is at its expense, that it becomes reduced little by little, and finally disappears entirely. This nurse, or rather vitellus of nutrition, may be compared to that of birds, fishes, &c., and the two vessels which form the cord for the embryos to the omphalo-mesenteric vessels or to the hepatic vein, which finally absorbs all the vitellus. Always bearing in mind that in Pyrosoma this vitellus of nutrition is common to all the four embryos, and is placed away from them in a true nurse.

Later, but while the heart of the nurse still exists, having become much smaller, each embryo also commences to present a heart, which beats independently, and apparently before it is traversed by a current of blood. It is seen laterally at the level of the mouth, but at the opposite surface, and it opens freely into the space which exists between the two tunics of the embryo. Now, then, all the five hearts beat, but those of the embryos are not synchronous with that of the nurse, and they commence their pulsations when that of the nurse pauses, but they are synchronous with one another, and always present the phenomena of alternation. However, these alternating pulsations of the hearts of the embryos are variable—sometimes slow, sometimes very quick, and with a different duration of pause. On one occasion I counted 74 pulsations, then a pause, a change in the direc-

tion of the current, and then 33 pulsations; then 133, 68, 139, 48, 28, 68, 38, 27, &c., with uncertain oscillations before or after the pause. It is necessary to remark that this uncertainty in the number and duration of the pulsations is observed less in individuals which are lively, and only just extracted from the Pyrosoma colony; moreover, if the water is from time to time changed, the current slackens at once. At last, the four embryos, having become adult and fully organized, remain alone. In the vascular cord which united them the movement of the blood ceases, and it diminishes, becomes atrophied, and only a few globules of the blood remain stationary and visible in the vessel of the interior of the body. The heart of each embryo now acts separately, and the circulatory apparatus is reduced to a great blood-sinus between the external and internal tunic, the latter being a little depressed at the poles of the embryo, and the sinus here becoming somewhat larger. The heart forces the blood into the sinus, and also into the little canals which exist between the branchial clefts, and in these cilia are now for the first time seen. I have several times seen the blood-globules traverse them slowly, one after another, through the whole length, and reappear at the extremity, to be poured into the general sinus, and was able also to verify this fact in the preceding stage of development, that is to say, when the vascular union between the embryos was still existing, but in this case the ciliary movement had not yet appeared. It is to be noted that, in consequence of the disposition of the parts of the embryo, the transverse elements of the branchiæ—that is to say, the clefts and the interposed canals—are placed in the direction of greatest diameter; by the elongation of the region of the mouth, these elements ultimately take their natural position.

It is known that, besides sexual generation, Pyrosoma presents contemporaneously a reproduction by buds, as was discovered by Professor Huxley, and seen also by Messrs. Keferstein and Ehlers. The embryos develope one after another on a peduncle or tube, which projects from beneath the end of the endostyle of the adult Ascidian, opposite to the heart, and is formed from its external tunic. Mr. Huxley has already pointed out that there is a vascular communication between the mother Ascidian and the embryos, which commences by a deflection of the blood-sinus of the Ascidian, and is continued to the neural surface of the embryo; and he states that it does not cease to exist until after considerable time, when the embryos are completely developed. I have seen that these budded embryos possess a

vessel which passes from the ganglion towards the mouth, turns round there to the left, and then passes along the endostyle, exactly as in the compound embryos, but I cannot say any more, because I have not had a favorable opportunity of observing the circulation in this form of embryo. However, we may conclude with certainty that it must take place in the same way as in the compound embryos.

It remains, finally, to consider how the circulation is carried on in the adult Ascidians, and here, for all that I have seen, I completely agree with the illustrious naturalists cited above. The heart lies at the extremity of the endostyle, has the ordinary form of a tube, and is enclosed in a pericardium. Its pulsations are alternate in the direction of their movement, variable in their duration, and interrupted by pauses of greater or less length. In one case I obtained the following numerical results:—34 pulsations towards the cloaca, then a very brief pause, followed by 20 pulsations towards the mouth; after these, 36, 12, 34, 13, interrupted by varying pauses and followed by uncertain oscillations, with three pulsations every five seconds; then 36 towards the mouth, 20 in the opposite direction, 28 again forwards, and so on. In another case 20 pulsations towards the mouth, then a pause for several seconds, followed by 43 pulsations directed posteriorly, intercalated by uncertain pulsations in one direction or the other.

The space between the two tunics of the Ascidian is occupied by the blood; it forms always the middle or vascular stratum, and presents the form of a great sinus, in which are found the ganglion, and in the superior part certain undetermined cellular organs; these are phosphorescent organs of M. Panceri. I cannot say that the blood passes behind them, since they are attached to the external stratum, and the sinus is not closed here, as Mr. Huxley thinks.

Below, the sinus expands in correspondence with the organs of digestion, which are immersed in it, and in the lateral sinuses which surround the ovary and the testicles. The branchiæ are all traversed by the blood in their transverse canals, between the clefts which are limited by nucleated, ciliated cells, being themselves attached to the internal tunic by their anterior and posterior surface, and communicating in consequence with the great sinus.

In all cases the globules of the blood are very numerous, round, and of about ·007 mm. in diameter. The external tunic of the vessels of the embryos is formed by a simple stratum of muscular fibre-cells, with very obvious nuclei.

In conclusion, it may be stated that—1. The circulation

in Pyrosoma is of the alternating type, whether in the adults, or in the embryos, or in the nurse (cyathozoid). 2. The circulation in the adults is lacunar and independent; in the embryos it is vascular, and common to the young colony. 3. The heart of the evanescent nurse presides over the circulation of the compound embryos, which is carried on by means of a double cord, derived from the development of a canal, and the vascular circle is closed in the nurse and in the last of the embryos. 4. The heart of the nurse is replaced by the hearts of the embryos, coexisting with the former during a certain time, but independent of it. 5. The circulation in the embryos, produced by budding, takes place as in the compound embryos, but is dependent on the mother, in place of the nurse. 6. A lacunar circulatory system commences at the same time that the vascular system begins to atrophy. 7. The pulsations of the heart are of variable duration.

On some peculiar FORMS *of* NAVICULA *from the* SULU ARCHIPELAGO. By Rev. E. O'MEARA, M.A. (With Plate XIII.)

(Read at Meeting of the Natural History Society of Dublin, March, 1872.)

GREAT diversity of opinion has existed among the most distinguished writers on the subject of the Diatomaceæ, as to the question whether Ehrenberg's separation of Pinnularia from Navicula is tenable or not. The ground on which this distinction is made rests on the character of the striæ, which in Pinnularia are supposed to be costate, while in Navicula they are moniliform. Kützing rejected this distinction, while W. Smith and Rabenhorst maintained its validity. Ralfs in 'Pritchard,' p. 892, included the forms of Pinnularia under the genus Navicula, and gives his reasons for adopting this course as follows:—"Were the costæ always plainly developed, as in *Pinnularia nobilis* and its allies, no difficulty could occur in determining the genera, but in many of the more minute species it is often very difficult to distinguish between striæ and costæ. We have not admitted Pinnularia here, partly for the reason just given, but principally because we cannot decide to which genus a large number of Ehrenberg's species should be referred." The existence of the distinctive characteristic is here admitted, but the genus founded on it rejected on account of the difficulty of applying it in many cases.

Grunow seems to regard the distinction of costæ and moniliform striæ in this case as founded only on insufficient observation; he says, "The so-called costæ in the Pinnularia are quite distinct from the ribs of other genera of Diatomace, and consist of a union of more or less confluent puncta, which, indeed, cannot be clearly discriminated except by the help of good amplification and well-managed illumination." ('Ueber neue oder ungenügend bekante Algen. Verhand. der K. H. Zool. Bot. Gesel.,' x B., 1860, p. 513.) Therefore, this eminent author has rejected the distinction between Navicula and Pinnularia, and is followed by Heiberg, Cleve, and others.

Schuman, who adopts the same view, indicates a peculiarity in some of the larger forms of Pinnularia. *P. nobilis* and *P. major* for example which is worthy of special notice, that is, the interposition of very fine striæ between the costæ, and which are indistinct in *N. nobilis*, but quite distinct in the case of *N. major*. These interstitial markings I have never been able to discover and Pfitzer makes the same remark concerning them. The last-named author, in his recently published treatise, 'Untersuchungen über Bau und Entwicklung der Bacillariaicen,' maintains the distinctiveness of the genus Pinnularia, not so much on the grounds on which it has hitherto been based, as on the following peculiarities:—1st. The so-called costæ are depressions on the surface of the valve; 2nd, the valves themselves are unsymmetrical; and 3rd, the arrangement of the cell-contents exhibits a marked difference from those of Navicula, both in the normal condition as also in the process of division. Concerning the characteristics just indicated, a few observations are needful; as to the first, there is great difficulty in applying it, except in the larger forms. As to the second, this admirable writer is at variance with all preceding authors on the subject, who have regarded the forms included under the genus Pinnularia as symmetrical. And to me they have ever appeared just as symmetrical as the Navicula. The third character is that which is most worthy of notice, but the forms in which the peculiarities have as yet been noticed, are comparatively few, so that we must wait for a more complete investigation of the species before we can regard them as satisfactorily established.

Such is a brief history of the vicissitudes of the genus Pinnularia, so far as I have been able to trace it. For myself, I have been long since disposed to regard the distinction as not quite satisfactory, but inclined at the same time to retain it for the purpose of convenience, inasmuch as

the species of Naviculæ are already so numerous. But my opinion has been greatly modified by the recent discovery of several forms in which the costate striæ of Pinnularia are found combined with the moniliform structure which is characteristic of Navicula.

For the material in which these forms are found I am indebted to the kindness of Capt. Chimmo, of H.M.S. Nassau, who states that he raised it from an extinct volcano from a depth of 300 feet, in the Island of Cagayan, Sulu Archipelago, north of Borneo, and remarks that the water was salt, and the mud yellow, and emitting a sulphurous smell. The mud contained a very large per-centage of calcareous matter, so that, after treatment with hydrochloric acid, the residuum was very small, but having a considerable number of interesting diatomaceous forms mixed up with a relatively large proportion of sponge spicules, and radiolarian organisms.

At present I mean to confine myself to those forms of Navicula which exhibited the double structure already noticed.

Navicula Chimmoana (Plate XIII, fig. 1).—Valve constricted, somewhat abruptly rounded off at the ends; length ·0053; greatest breadth ·0020; breadth at the constriction ·0017. Central nodule square, median line slightly sigmoid, and having a narrow unstriated band on either side; costæ distant, narrow, slightly radiate towards the apices, and nearly parallel at the middle; waved as they approach the free median band, on which they form a crenulated border; the space between the costæ filled up with a single row of large oblong dots, which run from the outer margin of the valve, and do not extend quite so far as to half the length of the costæ.

Navicula Suluensis (fig. 2).—Valve constricted, gently rounded off towards the somewhat lanceolate apices; length ·0076; greatest breadth ·0017; breadth at the constriction ·0013. Central nodule square, median line slightly sigmoid, and having a narrow unstriated band on either side; costæ distant, narrow, slightly radiate towards the apices, and nearly parallel to the middle; waved as they approach the free middle band, on which they form a crenulated border. The spaces between the costæ for about one third their length filled with a single row of oblong dots.

This form in many features strongly resembles *N. Chimmoana*, but is readily discriminated by the following characters: It is much longer and narrower, more graceful in its outline, and the border occupied by the moniliform dots is much narrower.

Navicula spiralis (fig. 3).—Valve constricted, abruptly rounded off towards the broadly lanceolate apices; length ·0050; greatest breadth ·0015; breadth at constriction ·0014. Central nodule quadrangular, longer than broad, with three linear projections on each side. Median line slightly sigmoid, close to which is a narrow band of costæ, apparently arranged in a spiral form. Costæ marginal, slightly radiate towards the apices, and nearly parallel in the middle, leaving a free space between them and the spiral band of costæ before mentioned. The space between the marginal costæ occupied by a double row of minute parallel punctate dots.

Navicula unipunctata (fig. 4).—Valve constricted, abruptly rounded off towards the broadly lanceolate apices; length ·0043; greatest breadth ·0010; breadth at constriction ·0009. Central nodule square; median line slightly sigmoid. Costæ distant, narrow, nearly parallel at the margin, and waved towards the median line, near which they terminate, forming a crenulated border. The space between the costæ occupied by a single row of minute punctate dots, which extend only a short distance from the margin, and form a narrow border.

Navicula bipunctata (fig. 5).—Valve very slightly constricted, abruptly rounded off towards the broadly lanceolate apices; length ·0044; greatest breadth ·0012; breadth at constriction ·00115. Central nodule is square, hollowed inwards on all sides; median line slightly sigmoid, having a narrow unstriated space on either side. Costæ radiate towards the apices for half the distance, and for the rest radiate towards the central nodule. The spaces between the costæ for about half their length occupied by a double row of minute punctate dots.

This form bears a strong resemblance to *N. unipunctata*, but is less constricted, longer and broader, and the border formed by the interstitial dots is broader, the dots being in double series, while in *N. unipunctata* the dots are in single series.

Navicula plutonia (fig. 6).—Valve much constricted; length ·0031; greatest breadth ·0011; breadth at constriction ·0009. Central nodule square; median line arched from centre to the apices. Costæ tolerably broad, radiate partly towards the apices, partly towards the central nodule, nearly reaching the median line. The spaces between the costæ for the greater part of their length occupied by a single row of small moniliform dots.

The practical result arising out of the discovery of the forms here described, as it strikes my mind, is to force us

either to abandon the distinction between Navicula and Pinnularia, or to institute a new genus to receive such forms as exhibit the peculiar characteristics of both genera. The former alternative seems the simpler, and I am therefore disposed to adopt it.

Description *of a* New Genus *of* Ixodea. By Alex. Macalister, M.B., Professor of Zoology, University of Dublin. (Plate XIV, figs. 5—8.)

The specimens of this parasite which I have examined I obtained from the skin of the many shielded pangolin of West Africa (*Manis multiscutata*), and as I have not met with any notice of a similar arachnidan, I conclude that the form is as yet undescribed, and as its distinctive characters seem of generie value I propose for the genus the name *Adenopleura*. The following will be its characters:

"Body compressed, rostrum dentate with flattened recurved many rowed hooks; abdomen with two lateral glandular sacs opening on the surface."

The species I would suggest to call *A. compressum*, with the following specific characters:

"Body very much flattened, obovate, posteriorly dentate, deep chestnut brown; rostrum clavate, matter more than once and a half as long as the basilar piece; claws two, uncinate, with an oval caruncle at base; length, 1-16th of an inch."

Both of my specimens were females, and they were both firmly connected to the skin of their host, with the rostrum buried in the surface of the soft under side of the animal. The rostrum is ·0125 of an inch long, double, and clavate, with parts of three rows of the recurved, blunt-pointed, hook-like teeth, with which it is beset, exposed. There are thirteen of these rows of teeth visible altogether on this very formidable beak, but the lowest six rows of these are closely adpressed, and look more like imbricated scales than teeth. The summit teeth are the smallest, sharpest, and most numerous. The mandibles are irregularly annulated on their surface. The palpi are somewhat clavate, with three joints, beset with hairs.

The surface integument of the dorsum is covered with irregularly undulated ridges, like the papillary ridges of the

finger-tips, having here and there slender hairs. The last joint of each of the light yellowish-brown limbs is the longest, and the claws are recurved, as in the sketch. The posterior third of the body has a dentated border, with eleven square-edged lobes. The intervals between these are marked on the surface by deep grooves, from which the surface ridges radiate.

Just in front of the first of these sulci, on each side are two subpyriform glandular bodies filled with globular, highly refracting cells. This sac has thick, uniform walls, and opens on the margin of the body at *b*, Plate XIV. A still more highly magnified view of this body is shown at fig. 3. I have not seen any organ like this in any other allied form.

The line separating the thorax from the abdomen is very faint. The compressed, scale-like shape of the body is well fitted to prevent the animal from being fatally squeezed between the imbricating plates of the host's defensive armour.

NOTE *on the* IMBEDDING *of* CRYSTALS *in the* WALLS *of* PLANT-CELLS. By W. T. THISELTON DYER, B.A., B.Sc. F.L.S. (With Plate XIV, figs. 1—4.)

IN describing in the January number of this Journal the occurrence of strings of crystal-bearing cells on the outside of the fibro-vascular bundles of the Screw Pine, I remarked that the thickened walls of the cells almost adhere to the contained crystals. I believe the explanation of this circumstance is supplied by a paper published by Dr. E. Pfitzer during last March in the seventh, eighth, and ninth numbers of 'Flora.' Count Solms had pointed out in the 'Botanische Zeitung,' in 1871, that crystals of calcium oxalate are formed within the actual substance of the cell-wall itself. His observations were made upon *Coniferæ*, and Dr. Pfitzer, in his paper, describes a similar occurrence in the leaf-parenchyma of some species of *Dracæna*. But in the case of *Citrus vulgaris*, where crystals occur apparently more or less completely imbedded in the cell-wall, Dr. Pfitzer has shown that the history of their formation is different. They originate, in fact, free from any attachment, in the middle of the protoplasmic cell-contents (fig. 1). Subsequently they appear, still without contracting any adhesion, to receive a coating of

cellulose. In the mean time the wall of the cell in which the crystal is contained (the occurrence of two within the same cell being rare) undergoes thickening, and this incrustation, which seems not to take place uniformly, ultimately brings the cell-wall into contact with one of the angles of the contained crystal. The deposition of cellulose still continuing (fig. 2), the crystal comes, at last, in some cases to be more than half buried in it; the newest layers of the cell-wall are continued over its whole surface, and the cavity of the cell becomes exceedingly reduced, and finally even obliterated.

The crystal-containing cells are found both in the leaf and in the neighbourhood of the fibro-vascular bundles of the stem. This latter circumstance turned Dr. Pfitzer's attention to the examination of the bark of other woody plants (dicotyledonous) in which Sanio had already demonstrated the existence, in numerous instances of crystal-bearing cells in the neighbourhood of the bast bundles. It is worth notice that this is precisely their position in the monocotyledonous Screw Pine. Dr. Pfitzer figures these crystal-bearing cells from the bark of the root of *Populus italica* (fig. 4), in which they are comparatively large, and therefore more easily examined. The crystals themselves have been dissolved out by hydrochloric acid, but the cavities proper of the cells are all but obliterated. Dr. Pfitzer has, however, no doubt that the crystals were originally free. He finds, in fact, all stages of transition between crystals which are surrounded by a thin film of almost solid protoplasm and those which have a coat of cellulose of every degree of thickness.

REVIEWS.

Archives de Zoologie Expérimentale et Générale. Published under the direction of HENRI DE LACAZE DUTHIERS. Nos. 1 and 2, January and April, 1872. Paris: Germer Baillière.

THE foundation of this journal at the present time, and the contents of the two numbers which have already appeared, form a brilliant proof of the vitality of biological science in France. The opinion has of late years been expressed, both in this country and in Germany, that the great French school has become exhausted, and that no successors of Bichat or of Cuvier are likely to arise. This would, indeed, be an irreparable loss, the scientific body of Europe would be deprived of one of its senses,

"And wisdom at one entrance quite shut out;"

for, with all its defects, of which Frenchmen are now beginning to be conscious, their school of anatomy and physiology had merits which no other seems likely to supply. Yet the ossibility of such a catastrophe was undeniable. In Italy, the birthplace of these as of every other science, the great anatomists of the sixteenth and seventeenth centuries have long ceased to have successors; and in England, the school of physiology founded by Hewson and Hunter, and continued by Bell and by Marshall Hall, has all but completely died out. In France, the influence of the Second Empire proved as evil for science as for every other department of higher national life. With almost universal ignorance of the great advances made in Germany during the last twenty years, the French *savans* neglected even to follow out the paths they had themselves opened, and with rare exceptions discovered no fresh ones. But now, under the restoring breath of liberty, there is a revival of science, which promises to preserve all their best national qualities, united with a docility and a thoroughness which they have learned from their late enemies. Already in England, and even in Germany, we have much to learn from them.

In one of the last discussions in the 'Académie des Sciences' before the war, our great English zoologist was

spoken of as an amateur. In the only sense in which the epithet is true of Mr. Darwin, it also applies to M. de Lacaze Duthiers, since he, too, pursues science for the love of it. His former labours have earned him a distinguished place in European science, and he deserves more than national gratitude for the courage and enterprise which have led him to found these archives of zoology.

The first number was already printed nearly two years ago, when its publication was arrested by the declaration of war. In a few lines of introduction the editor speaks of its reïssue as a proof of confidence in the future, and continues:

"Le réveil du mouvement intellectuel en France est à nos yeux chose assurée. Il a sa raison dans notre défaite. Il doit être sans limites, comme nos désastres et nos malheurs."

The field which the journal seeks to occupy, "la zoologie expérimentale et générale," is further defined as including "histoire naturelle, morphologie, histologie, évolution des animaux." The principal title, "zoologie expérimentale," though, perhaps, not quite so strictly limited as the corresponding term in English would imply, is too restricted without the qualifications which follow, and with them scarcely accurate. The question, however, how far zoology can be called an experimental science, is discussed at length by the editor in the first article, "Direction des Études Zoologiques;" and it is on this subject that the following criticisms are offered.

M. Lacaze Duthiers begins by pointing out that the first step in the history of the natural sciences is "contemplation" of surrounding objects; then follows their collection, description, or reproduction by art. The next step is to classify or arrange these objects, and to invent for them a convenient nomenclature. After describing the reforms of Linnæus as the completion of this second period, our author defines the new path in zoology which was opened by Cuvier's anatomical researches as the path of experiment.[1] In vindicating the experimental character of zoology, he proceeds to discuss a dictum of M. Claude Bernard, that while physiology is, like physics and chemistry, a "science d'expérimentation, explicative, active, et conquérante de la nature," zoology belongs to the sciences of contemplation and observation, like mineralogy, geology and botany.

Now, eminent as have been M. Bernard's services in his own department, he seems scarcely entitled by universality of

[1] It is remarkable that in his rapid but able sketch of the progress of zoology M. Lacaze Duthiers does not even mention the illustrious name of Hunter.

study or depth of philosophy to lay down the precise limits of each branch of science; and to most Germans and Englishmen it will seem strange that a man of Lacaze Duthiers' merit should trouble himself as to the title given to such researches as that on the otocysts of molluscs, published in this journal.

> "Let him name it who can, its beauty is still the same."

Still, if a barren controversy about words can be avoided, it may be well to consider how far zoology can be reckoned, with chemistry and physiology, an experimental science.

In M. Bernard's 'Report on the Progress of Physiology in France' (1867), he says:—"L'observation considère les phénomènes dans les conditions où la nature les lui offre. L'expérimenteur les fait apparaître dans les conditions dont il est maître;" and, again:[1] "Nous ne pouvons que regarder les phénomènes dus à l'observation tandis, que nous pouvons faire apparaître ou disparaître ceux de l'expérience suivant notre volonté."

The broad distinction between observation and experiment, as methods of acquiring knowledge, has been common property since the time of Bacon; but it is only a broad distinction, and no hard line can be drawn between the two. Thus, descriptive anatomy, which has always been considered the type of a science of observation, is far from being a mere passive contemplation of objects. A well-dissected limb is in anything but a natural condition. Every process of injection, preservation, and dissection is a step away from the purely "contemplative" view of the phenomenon; and when minute anatomical structure is investigated, the process becomes still more complicated. A section of skin, with the vessels injected with blue solution, hardened in chromic acid, embedded in gum, its nerves stained with gold, its epithelium with nitrate of silver, and its nuclei with carmine, is this "une phénomène dans les conditions où la nature la lui offre"? Why is not trying what will be the "behaviour" of a leucocyte with magenta as much an experiment as feeding a vorticella with carmine? and why is not either process as much an experiment, according to M. Bernard's definition, as regulating the supply of food sent through the arteries to the elements of a rabbit's ear by dividing its sympathetic nerve?

The fact is, that mere passive "contemplation of phenomena in the conditions which nature offers" is not science at all: it is the business of the artist, not of the philosopher.

[1] 'Revue des Cours Scientifiques,' 1869.

The child who stretches out his hand, and tries how far the impressions of touch, of temperature, and of muscular sense agree with those of sight, has already entered on the path of experimental science. When the form of an animal has been ascertained by such a process, the knowledge of its simplest functions is gained as much by experiment as by observation; and in the further study of the object, from the roughest descriptive anatomy to the most refined experiments upon the processes of its nervous system, observation and experiment must go hand in hand.

It may suffice for the poet or the painter to see a face in one aspect only, but the zoologist must see it on both sides, must bring every available sense to bear, must measure, and weigh, and test, and thus seek to verify his first impressions. The real contrast is not between physiology as a science of experiment and zoology as one of observation, but between physiology as the study of the functions, and morphology as that of the structure, of living beings—the two, with organic chemistry, completing the comprehensive science of biology. Descriptive or topographical anatomy and histology are merely convenient departments of morphology. Zoology, which once meant the whole science of organisms between man and plants, is now properly merged in biology, since the advance of knowledge has shown that we cannot entirely separate the study of the structure and functions of the so-called lower animals from that of "the animal best known to us," on the one hand, and from that of plants on the other; but the term zoology is still retained, sometimes qualified by the epithet descriptive, to denote a branch of biology almost exclusively confined to determining the species of animals and arranging them in a suitable classification. Now, specific characters are nothing but those anatomical characters which are most easily determined; and thus it is a mere accident that zoology seems to have most to do with external, and comparative anatomy with the internal organs of animals. Again, a good classification is one of two things: it is either a convenient plan for stating and remembering a multitude of anatomical facts, or else it is based on some general biographical theory, such as creation by type or development by evolution.

Thus, we see that zoology is only a branch of the general history of organic beings, and animal physiology is no more. All zoology may be divided between morphology and physiology; but just as for convenience we distinguish between descriptive zoology and comparative anatomy, so we may distinguish between the study of the habitat, food, mode of life

and reproduction of each animal, which is strictly physiological, and that of the more "general" functions of its internal organs, which is generally recognised as comparative physiology; for, just as since Bichat wrote, we have recognised that minute anatomy is general anatomy, so the functions of the various organs and tissues of animals are almost always more general, and therefore more important to one who, like M. Bernard, is chiefly interested in human physiology, than the functions exhibited by the same animal as an entire organism. But, when it is pretended that the study of the function of respiration is really the study of the behaviour of red blood discs, we see at once how far wrong an eminent man of science may be led by a narrow and one-sided view of his own subject.

If what has been stated above be true, it follows that half "zoology" is comparative physiology; and, so far, it will be allowed to be an experimental science, even by M. Bernard; the other half is descriptive, but not more so than the minute anatomy of the tissues, which is necessary to the most experimental and "dominant" physiology, and which has often done duty in text-books and examinations for the real study of animal functions.

Even physiology, in the strictest sense, is not a purely experimental science. Of the two most brilliant discoveries made by Englishmen, while Sir Charles Bell's was made by direct experiment, that of Harvey was founded on teleological deductions from anatomical facts, and was not confirmed by actual observation till after his death. Vivisection is not the only way of gaining increased knowledge in physiology. What we need in this, as in other so-called experimental sciences, is a number of observations—not isolated, but repeated, not made under one, but under many different conditions—mutually checking and controlling each other; and such a series is often as well attained by observation of the experiments which nature is continually making before our eyes as by of those which we make in our laboratories, more or less clumsily, for ourselves.

There is, however, another aspect in which zoology, using the term in the most restricted sense, may be ranked with chemistry, physics, and physiology. Besides description of animals, it includes their classification. Now, if we attempt to make this more than a convenient arrangement for the memory, if we try to express by it their true relations, this branch of zoology becomes at once "experimental." As soon as any hypothesis of the way in which species have arisen is adopted, every fresh observation of structure, or function, or

mode of development, helps to verify or disprove this or that detail of the scheme. It is from this point of view that embryology has acquired such increased interest since the publication of Darwin's, Wallace's, and Haeckel's writings. Breeding pigeons, to ascertain what effect the union of particular races will have on the form of their offspring's skull; manipulating the egg of a mollusc, so as to obtain a brood of monsters,—these are surely as much experiments as watching what will happen if you remove a dog's hemispheres.[1]

It appears, therefore, that while there is an important distinction between a mere passive contemplation of an object and a scientific observation, there is no sharp line to be drawn between observation and experiment. Every experiment must be followed by observation, or it is useless; and every observation in biology may be regarded as the description of a ready-made experiment. Moreover, while the title "Experimental Zoology" is unnecessary, and perhaps misleading, the fact remains that zoology, in the proper sense of the word, includes animal physiology, experiments, observations and all; and that, even in its restricted and conventional sense, it needs, as a science of classification according to genetic affinities, just the same methods as any theory of secretion or innervation.

Lastly, when these broad facts are recognised, it becomes a matter of very little importance what name is given to any particular investigation. So long as M. Lacaze Duthiers continues to publish papers like that which follows the introductory chapter of this journal,[2] he may be sure that biologists will accept them thankfully, under whatever title he pleases to present them.

P. H. Pye-Smith.

[1] In the kindred science of pathology almost nothing has yet been learned by direct experiment. All that is known has been gained from descriptive and minute anatomy, and from the ready-made experiments of nature; now, however, and in England of all countries—thanks to the University of London—we are likely to learn what experimental and comparative pathology can teach.

[2] See the "Chronicle" for this and other papers.

Microcythæmia; a Morbid Condition of the Blood hitherto undescribed.[1] By Professors VANLAIR and MASIUS.

IN this memoir the authors designate by the name of "microcythémie" a disease of which they believe the principal character to consist in a special alteration of the blood morphologically expressed by the presence of an enormous number of red corpuscles different from the ordinary red corpuscles. To these they assign the name "microcytes," from their small size, and the name *microcythæmia* is formed on the model of *leucocythæmia*. The observation of one case furnished the authors with the chief groundwork of their paper, and we shall follow them in prefixing a short relation of it to our summary of the memoir.

A young married lady, after the birth of a child, began to suffer from the following symptoms—pain in the splenic region, cardialgia, painful vomiting, general jaundice, and constipation. No gall-stones; fæces not pale. In addition great weakness and gradual enlargement of the spleen. Subsequently, aphonia without labial or laryngeal paralysis, followed by incomplete loss of power in, first upper, then lower, limbs. The jaundice gradually disappeared. The paralysis was more marked in upper than lower limbs, and was accompanied by atrophy, with occasional intense pain. There was no sign of want of co-ordinating power. The jaundice and most of the symptoms improved, but the paralysis and muscular atrophy increased.

The most remarkable change was, however, in the blood.

The blood was examined four times, once immediately after venesection, the other times some hours after, but having been carefully preserved in hermetically sealed tubes. A considerable quantity was obtained by deep incisions and scarifications.

The macroscopic appearance of blood was quite natural, as was also its coagulation.

Microscopically, it presented the following appearances:— The white corpuscles slightly less numerous than ordinarily the case, and none exceeding ·01 mm. in size. The red corpuscles also natural in colour, size (·006 to ·008 mm.), and shape. They some of them formed rouleaux, others became spinous. The plasma was colourless. However, in the meshes of the irregular network formed by the rouleaux were seen a

[1] 'De la Microcythémie,' par MM. Vanlair et Masius, Professeurs à l'Université de Liège. Bruxelles, 1871.

large number of the bodies which the authors call "microcytes." They are characterised, not only by their small size, but also by certain peculiar properties.

Their *shape* is perfectly spherical, and their surface perfectly smooth, even when examined with very high powers. Their *diameter* is in the immense majority of cases ·004 mm., perhaps one in a hundred rather smaller, but they never fall below ·003 mm. The *colour* is the same as that of the red corpuscles, but, perhaps, a little darker. They are highly refracting, and thus contrast with the ordinary disks. They do not agglomerate like the ordinary corpuscles, but remain isolated between the masses of the latter. They are extremely mobile, being easily displaced by the smallest movement of the cover glass. As to their *nature,* these bodies are certainly not themselves nuclei, and do not contain nuclei. Their *number* was found in the earlier observations made to be at least equal to that of the ordinary red disks. In later observations the number of *microcytes* was greatly in excess. At the last examination, indeed, there were found to be not more than one or two normal red corpuscles to a hundred microcytes.

Besides the typical form of microcytes just described, there were found certain intermediate forms; for instance, some were as large as ·005 mm. in diameter, with some appearance of a central depression and without the brilliancy of the microcytes; these were seen especially at the commencement of the disease. Others, again, were as brilliant as the ordinary form, but measured ·005 mm. in diameter. These were chiefly seen at the last examination of the blood.

In general, no alteration was observed in the blood while under observation, but once only, on the last occasion when the blood was examined, the number of spherical globules visibly increased, but these spherical bodies formed out of the discoid were always rather larger than the previously existing microcytes. After maceration for two days no rouleaux are seen, and most of the discoid corpuscles become spherical, but they may still be distinguished from the microcytes. The action of heat on the microcytes is similar to the effect it produces on the red disks; in both cases segmentation occurs, but less readily in microcytes than in the ordinary disks. Distilled water has no effect on their form or size, but slowly decolourises them. Acetic acid and dilute solution of potash dissolve the spherical as they do the discoid corpuscles.

The urine showed no special abnormality, beyond a large quantity of uric acid.

The subsequent history of the patient is remarkable. About a year after the disease had reached its climax, nearly two years after its commencement, a marked improvement took place in all the symptoms, and on examination of the blood it was found to contain not a single microcyte, the red and white corpuscles being normal, and present in normal proportions, the only noticeable fact being that the red corpuscles were rather small.

Analysing the morbid phenomena presented by this case, the authors first discuss the *enlargement of the spleen*. This was clearly not due to amyloid degeneration, since this did not show itself in any other organ; nor was it the hypertrophy which is accompanied by leukæmia, the latter symptom being absent. It was equally distinct from the enlargement due to intermittent fever, and from the temporary swelling observed in typhoid or other febrile affections; in fact, it appeared to be an affection *sui generis*.

The same might be said to be true of the enlargement and subsequent atrophy of the liver, this being not referable to any of the ordinary causes of atrophy of this gland.

As to the small globules seen in the blood of this patient, they were decidedly different from the ordinary red globules —first, in their smaller size; secondly, in their spherical shape. Bodies somewhat similar have been seen by various observers. Lehmann first noticed that the red globules of the portal vein were smaller and more spherical than those of other parts of the circulatory system, and unusually resistant to the action of water and acetic acid. Funke saw similar globules in the splenic vein. Max Schultze described red globules smaller than the ordinary ones, and of spherical shape, either crenated or granular, from the blood of several persons; and this observation was confirmed by Klebs, who described also some small spherical globules having a uniform surface; none of these observations, however, precisely accords with that of the author's. Schultze was unable to decide with perfect certainty whether the globules observed by him were pre-existent in the blood, or altered after removal from the vessels. The authors have, however, been able to determine positively that their "microcytes" existed as such in the blood.

The distinctive characters of microcytes are summed up as follows:—Perfectly spherical form, remarkable permanence of shape, power of resistance to reagents, constant isolation in the field of the microscope, excessive refractive power, smallness and uniformity of size. In attempting to define their physiological nature two suggestions are made—that

they may be transitional forms between the white and the red globules, or that they may be a stage in the retrograde metamorphosis of the red globules. The former supposition is obviously untenable, since forms intermediate between white and red corpuscles are known, and are different from microcytes; and it seems, therefore, more probable that microcytes are atrophic forms, that is to say, red corpuscles which are in course of destruction, the more so as the artificial destruction of red corpuscles by heat, pressure, or desiccation, produces very analogous forms. Thus, the white corpuscles would come to represent the infancy of the blood-elements, the red corpuscles their adult stage, and microcytes the period of old age.

The cause of so grave an alteration of the red corpuscles remains still obscure, but the spleen and liver both suggest themselves as possible seats of the change. Among many conflicting opinions as to the function of the spleen, several authorities agree in attributing to it a destructive action on the red globules, while a more general consensus of opinion ascribes the same function to the liver. The theory which the authors found upon the case observed by them is as follows:—That the spleen, though not destroying the red corpuscles, alters them and prepares them for destruction, converts them, that is to say, into microcytes, which are further destroyed in the liver, though in neither place does the change affect more than a small proportion of the corpuscles.

Supposing that the spleen should undergo hypertrophy, and its action on the blood-corpuscles be proportionally intensified, the number of microcytes sent into the circulation by the splenic vein will be proportionally increased; and this increase will be greater still if there should be a simultaneous atrophy, that is to say, diminished action of the liver, which would thus destroy a smaller number of microcytes. The proportion of these in the blood might then become quite enormous. This theory is thought to explain more simply than any other the fact that the composition of the blood remains almost unaltered after the extirpation of the spleen. If, normally, the only action of the spleen on the blood is to produce *microcytes*, and the normal function of the liver be to destroy them, while the latter organ remains sound the blood will not betray by its composition whether the number of microcytes formed be large, small, or actually none at all, that is to say, whether the action of the spleen be vigorous, feeble, or *nil*.

The authors have made numerous researches on the blood of men and animals to test the truth of their views.

In human blood they find that a very small number of microcytes are often present in a state of health, but that their existence is not constant.

In various diseases they have found a few microcytes, as, for instance, in typhoid fever, in puerperal fever of a pyæmic character, in one case of acute rheumatism, and in acute pneumonia; among chronic diseases, in cirrhosis of the liver and constitutional syphilis; but the number was always inconsiderable.

Observations on the blood of animals showed that, while birds and frogs had no microcytes, they were found normally in mammalia (especially the rabbit and the guinea-pig), in the blood of the splenic vein, except when the animal was killed fasting, while they were constantly absent in the blood of the hepatic vein. These facts are the main support of the theory that microcytes are formed in the spleen and destroyed in the liver.

The authors further analyse the remaining symptoms presented by the case which form the groundwork of their treatise. The jaundice they believe to have been hæmatogenic, only owing to the presence in the blood, not of bile-pigment, but of a substance derived from the blood—the *hæmapheic* icterus of Gübler. The urine was also found to contain in excess various substances which might be derived from retrograde metamorphosis or oxidation of blood-corpuscles. The paralysis they believe to have been due to affection of the nerve centres.

The simultaneous occurrence of these various symptoms the authors believe to be attributable to no known disease, and hence they feel themselves justified in regarding *microcythæmia* as a true morbid entity. Further, they have the record of a precisely similar train of symptoms having occurred previously to a sister of their patient, although in that case, which was fatal, nothing was known of the state of the blood.

NOTES AND MEMORANDA.

Sir,—In the last number (No. XLVI, p. 118), is a "preliminary communication" on the subject of the "Artificial Production of some of the Principal Organic Calcareous Formations," by Prof. Harting, of Utrecht.

As I am only acquainted with Prof. Harting's observations from the "abridged report" given in your Journal, of course I speak with due reservation as to what may be contained in the completed memoir. But it is strange to see, at any rate, in the pages of the 'Microscopical Journal,' a paper on the subject in question, in which the name of Mr. George Rainey does not appear, to whom alone, so far as I know, is all originality with regard to it due.

Many years since (1857—1861) Mr. Rainey's observations on the formation of globular crystalline masses of carbonate of lime, &c., in mucilage of gum arabic, and other fluids containing organic colloid matter, were published in the 'British and Foreign Medico-Chirurgical Review,' the 'Quarterly Journal of Microscopical Science,' and the 'Transactions of the Microscopical Society,' whilst some of the general results were collected in a separate work, 'On the mode of Formation of the Shells of Animals, of Bone, and of several Structures by a Process of Molecular Coalescence.'[1] These various communications give the results of numerous carefully conducted experiments, and are filled with highly ingenious and suggestive observations and remarks, well worthy of more attentive consideration than they have as yet received.

So far as I can see, there is nothing in Professor Harting's "preliminary communication," including the figures, which may not be found in Mr. Rainey's papers. If Professor Harting, as seems scarcely possible, should be unacquainted with the labours of his predecessor, it is as well he should become so before the publication of his memoir *in extenso*, when, I have no doubt, he will do full justice to Mr. Rainey.

I am at all events glad to find that such an interesting subject as that of the so-termed "Molecular Coalescence"

[1] London, Churchill, 1858, 8vo, pp. 160.

should have attracted renewed attention, and is in such able hands as those of Professor Harting.

I am, yours obediently,

GEO. BUSK.

To the Editors of the 'Quarterly Journal of Microscopical Science.'

Spontaneous Generation.—At the Royal Society, on March 21st, a paper was read on "Some Heterogeneous Modes of Origin of Flagellated Monads, Fungus-germs, and Ciliated Infusoria," by Professor H. Charlton Bastian, F.R.S. In this communication Dr. Bastian announces results which, whilst confirming the previous observations of MM. Pineau and Pouchet, considerably extend our knowledge concerning the heterogenetic changes liable to take place in the pellicle (composed of aggregated Bacteria) which forms upon an infusion of hay. He describes all the stages by which (as he supposes) certain Fungi, Flagellated Monads, and Ciliated Infusoria are produced, as a result of changes taking place in the very substance of the pellicle. Most of the observations were made under a magnifying power of 1670 diameters, and, although more extensive, are confirmatory of others published in 'Nature,' No. 35. Dr. Bastian says, "I now wish to describe other allied processes, and the means by which I am enabled to obtain, almost at will, either animal or vegetable forms from certain embryonal areas which are produced in the pellicle." The simplest mode of origin of Fungus-germs and Monads is thus described:—"The pellicle which formed on a filtered maceration of hay during frosty weather (when the temperature of the room in which the infusion was kept was rarely above 55° F., and sometimes rather lower than this) presented changes of a most instructive character. On the third and fourth days the pellicle was still thin, although on microscopical examination all portions of it were found to be thickly dotted with embryonal areas. Nearly all of them were very small; but a few areas of medium size were intermixed. The smallest were not more than $\frac{1}{4000}$th of an inch in diameter, and these separated themselves from the pellicle as single corpuscles; slightly larger areas broke up into two or three corpuscles; and others, larger still, into 4—10 corpuscles. In most of these small areas the corpuscles were formed with scarcely any appreciable alteration in the refractive index of the matter of which they were composed; this simply became individualised, so that the corpuscles separated from the surrounding pellicle and from their fellows, still presenting all the appearance of being portions of the pellicle, and exhibiting from 4 to 10 altered Bacteria in their interior. In some cases the products

of segmentation soon developed into actual flagellated Monads in a manner presently to be described; whilst in others they seemed to remain for a longer period in the condition of simple motionless corpuscles. Other solitary corpuscles or small areas began to form in the pellicle in precisely the same manner, though they speedily assumed a highly refractive and homogeneous appearance. Why some should undergo such a change, and not others, seems quite impossible to say. One can only assert the fact, and add that these highly refractive ovoid corpuscles were, for the most part, more prone to produce Fungus-germs than Monads. Many of them soon grew out into dissepimented fungus filaments, which rapidly assumed the *Penicillium* mode of growth. The spores, which were abundantly produced in terminal chaplet-like series, were, however, small, homogeneous, spherical, and colourless." In other cases Monads and Fungus-germs are produced from the pellicle in precisely the same manner as that by which they arise within the terminal chambers of certain Algæ or Fungi—that is to say, they result from the segmentation of a mass of homogeneous protoplasm.

In speaking of such a mode of origin of Monads, Dr. Bastian says:—"Contrasting with the very pale fawn-colour of the evenly granular pellicle, there were numerous areas of a whitish colour, refractive, and more or less homogeneous. These areas differed very much in shape and size; some were not more than $\frac{1}{1000}''$, whilst others were as much as $\frac{1}{150}''$ in diameter. Their shape was wholly irregular. As in the instances previously recorded, the first appreciable stage in the formation of an embryonal area in the pellicle was a local increase in the amount of gelatinous material between the units of this portion of the pellicle, so that they became more distinctly separated from one another than in adjacent parts. Gradually these particles became less sharply defined, and at last scarcely visible, in the midst of a highly refractive protoplasmic mass which began to exhibit traces of segmentation. Masses of this kind were seen, which had been resolved by such a process of segmentation into a number of spherical corpuscles about $\frac{1}{4500}''$ in diameter. These were at first highly refractive, though they gradually became rather less so, and revealed the presence of two or three minute granules in their interior. In other adjacent areas a number of densely packed, pliant, and slightly larger corpuscles were seen actively pushing against one another. When they separated, they were found to be active ovoid specimens of *Monas lens*, about $\frac{1}{3500}''$ in length, and provided with a vacuole and a rapidly lashing flagellum."

In other cases embryonal areas of the same nature were formed, which went through similar processes of segmentation; although the units produced, instead of developing into Monads, were seen to become transformed into brown vesicular bodies, which subsequently germinated into Fungus-filaments. Whilst affirming that he is now able to determine pretty surely the occurrence of either one of these phenomena, Dr. Bastian says:

"Experience has shown me that, if an infusion has been heated for a time to 212° F., the pellicle which forms on its surface very frequently never gives rise to an embryonal area. If the infusion has been prepared at a temperature of 149°—158° F., the embryonal areas which form will give origin to Fungus-germs; whilst in a similar infusion prepared at 120°—130° F., the embryonal areas, which seem at first to be in all respects similar, break up into actively moving Monads."

Dr. Bastian then proceeds to give an account of the origin of *Paramecia*, laying stress upon the fact that, in order to obtain such organisms, it is necessary to employ a filtered infusion made with cold water. His observations on this subject were, in the main, confirmatory of those of M. Pouchet. Thousands of egg-like bodies, varying in size from $\frac{1}{800}''$ to $\frac{1}{350}''$ were seen developing throughout the whole substance of a thick pellicle. He says—"It seemed to me that the differentiation took place after a manner essentially similar to that by which an ordinary 'embryonal area' is formed. The small embryos did not appear to represent the earlier stages of large embryos; and it seemed rather that spherical masses of the pellicle of different sizes began to undergo molecular changes, which terminated in the production of *Paramecia* of a correspondingly different bulk. Just as in the previously described embyonal areas masses of different sizes began to exhibit signs of change, so also here spherical portions of the pellicle, differing within the limits above mentioned, began to undergo other heterogenetic changes. This was first indicated by an increased refractiveness of the area (especially when seen a little beyond the focal distance); and almost simultaneously a condensation of its outer layer seemed to take place, whereby the outline became sharply and evenly defined. At this stage an actual membrane is scarcely appreciable, and the substance of the embryo (when examined at the right focal distance) scarcely differs in appearance from the granular pellicle of which it had previously formed part. So far as it could be ascertained, the individual embryos did not increase in size, although they went through the following series of developmental changes. The contained matter

became rather more refractive, and the number of granules within diminished considerably, whilst new particles after a time seemed gradually to appear in what was now a mass of contractile protoplasm. These new particles were at first sparingly scattered, though as they were evolved they continued to grow into biscuit-shaped bodies, which sometimes attained the size of $\frac{1}{10000}''$. All sizes were distinguishable; and many of them moved slowly amongst one another, owing to the irregular contractions of the semifluid protoplasm in which they were imbedded. Gradually the number of homogeneous biscuit-shaped particles increased, and at last a large vacuole slowly appeared in some portion of the embryo. It lasted for about half a minute, disappeared, and then, after a similar interval, slowly reappeared. Much irregularity, however, was observed in this respect. The next change that occurred was the complete separation of the embryo from the cyst which it filled, and the commencement of slow axial rotations. These rotations gradually became more rapid, though they were not always in one direction. The mass became more and more densely filled with the large biscuit-shaped particles, and at last the presence of cilia could be distinctly recognised on one portion of the revolving embryo. Then, as M. Pouchet stated, the movements grew more and more irregular and impulsive, so as at last to lead to the rupture of the thin wall of the cyst—when the embryo emerged as a ciliated and somewhat pear-shaped sac, provided with a large contractile vesicle at its posterior extremity. . . . . On emerging from the cyst, all the embryos, although differing somewhat in size, were of the same shape. This closely corresponded with the description given of *Paramecium colpoda* in Pritchard's 'Infusoria,' namely, 'Obovate, slightly compressed; ends obtuse, the anterior attenuated and slightly bent like a hook.' Cilia existed over the whole body, though they were largest and most numerous about the anterior extremity. No trace of an actual buccal cleft could be detected; and (except in the posterior portion of the body, where a large and very persistent vacuole was situated) the organism was everywhere densely packed with the large, homogeneous, biscuit-shaped particles. For many days these most active Infusoria seemed to undergo little change, though afterwards the number of the contained particles gradually began to diminish, whilst the body became more and more regularly ovoid, and a faint appearance of longitudinal striation manifested itself, more especially over its anterior half. At the same time a very faint and almost imperceptible mass ('nucleus') began to appear near the centre of the organism;

and when examined with a magnifying power of 1670 diameters, a lateral aperture (mouth) $\frac{1}{8000}''$ in diameter was seen, which was fringed by short active cilia, arranged like the spokes of a wheel. These peculiarities correspond very closely with those of an embryo *Nassula*. Very many were seen with similar characters; and multitudes existed in all conditions intermediate between this stage and that of the simpler organism which first emerged from the cyst."

Dr. Bastian concludes by saying:

"It will, of course, be seen that the phenomena which I have described as taking place in the 'proligerous pellicle' may be watched by all who are conversant with such methods of investigation. We do not require to call in the aid of the chemist; we need exercise no special precautions; the changes in the pellicle are of such a kind that they can be readily appreciated by any skilled microscopist.

"Just as I have supposed that living matter itself comes into being by virtue of combinations and rearrangements taking place amongst invisible colloidal molecules, so now does the study of the changes in the 'pellicle' absolutely demonstrate the fact that the visible new-born units of living matter behave in the manner which has been attributed to the invisible colloidal molecules. The living units combine, they undergo molecular rearrangements; and the result of such a process of heterogenetic biocrasis is the appearance of larger and more complex organisms, just as the result of the combination and rearrangement between the colloidal molecules was the appearance of primordial aggregates of living matter. Living matter is formed, therefore, after a process which is essentially similar to the mode by which higher organisms are derived from lower organisms in the pellicle on an organic infusion. All the steps in the latter process can be watched; it is one of synthesis—a merging of lower individualities into a higher individuality. And although such a process has been previously almost ignored in the world of living matter, it is no less real than when it takes place amongst the simpler elements of not-living matter. In both cases the phenomena are essentially dependent upon the 'properties' or 'inherent tendencies' of the matter which displays them."—*Nature.*

The Organ of Corti.—At the Royal Society, on May 30th, a paper was read, "On the Structure and Function of the Rods of the Cochlea in Man and other Mammals," by Urban Pritchard, M.D.

The aim of this paper is to describe the true construction and use of the cochlea, so far as its task of distinguishing

the various sounds is concerned. This cochlea, it must be borne in mind, consists of a spiral canal, in form and shape very similar to the inside of a snail-shell. From the axis of this spiral there proceeds horizontally a plate of bone, the *lamina spiralis*, almost dividing this canal into two. From this plate again there extend two membranes, the membrane of Russner, and the Lamina spiralis membranacea, as far as the wall of the canal, thus separating it into three minor canals.

Between the layers of the membranous spinal lamina are situated the so-called rods of Corti. These were first discovered and described by the Marquis de Corti; and although since then many observers have studied the subject, yet scarcely two investigators are agreed as to their exact form.

In a general view of the rods from above, they appear similar to two rows of pianoforte-hammers, rather than like the keys of that instrument, to which they have been likened. In a lateral view, these two rows of rods are seen sloping towards each other, like the rafters of a gabled roof. The rods consist of a shaft and two enlarged extremities, but the two rows differ considerably in form; the inner rods are attached by their lower extremities to the membrana basilaris at its junction with the lower lip of the limbus, and just external to the spot where the nerve-filaments emerge. They are directed outwards and upwards, with a slight undulation to meet the outer rods. The lower extremity is enlarged and rounded, gradually tapering to the shaft, which is cylindrical; the upper extremity is somewhat cuboid in form, but the outer surface is deeply concave, and the upper lip of the concavity is prolonged into a process.

The outer rods are attached to the membrană basilaris by a broad base, which also gradually tapers to a cylindrical shaft. Their upper extremity is less cuboid in form, and presents a convex internal surface, which articulates with the corresponding concavity in the inner rods just mentioned; from the outer and upper part there extends outwards a slender process.

One of the most important features with regard to these rods is their relative length. Most authors state that there is very little difference in the length of the two rods; in this, however, they are much mistaken; for not only do the two sets of rods differ in this respect, but the length of each varies according to its position on the cochlea. Thus, at the base, the outer rods are as nearly as possible equal in length to the inner, but proceeding upwards, both rows increase in length with great regularity, although not in the same ratio,

the outer increasing with much greater rapidity, so that near the apex they are twice the length of the inner.

It was generally supposed, *à priori*, that these rods were graduated so as to distinguish the most minute variation of tone, but no one until now has been able to demonstrate this.

The rods, therefore, vary in length from about $\frac{1}{500}$ to $\frac{1}{400}$ of an inch. The number of rods in each row is not the same, there being about three of the inner to two of the outer, and, according to calculation, there are about 5200 inner rods and 3500 outer in the whole cochlea.

Corti and most other authors considered this system of rods to be the essential portion of the cochlea; they supposed the rods received the vibrations conducted to them, and being set in motion, so affected the nerves as to cause the brain to appreciate the various sounds. Later German writers have attributed the appreciation of the various vibrations to certain delicate cells, which are attached to the under surface of the membrana reticularis. From this circumstance alone it appears very evident that these investigators had not suspected, much less discovered, the fact that the rods are most exquisitely graduated, for otherwise they could surely never have doubted that so beautiful and suitable an apparatus could have any other ostensible purpose than that of appreciating the various sounds. I consider, indeed, that the cochlea represents a musical instrument, similar in nature to a harp or musical box, the strings of the one and the tooth of the other represented by the rods of Corti. The spiral bony lamina is simply a sounding-board; around the rods are placed the various nerve-cells and nerve-fibres, and from these cells the impressions are conveyed by the fibres to the brain itself.

It is possible, therefore, to trace very completely the course of sounds or vibrations from a musical instrument or any other source to the brain, through the medium of the ear. First the vibrations are caught and collected by the auricle, and transmitted through the external meatus to the drum of the ear, next across the middle to the internal ear. Here the sound is appreciated, merely as a sound, by the vestibule; the direction is discovered by means of the semicircular canals; but to distinguish the note of the sound, it must pass on to the cochlea. The vibration therefore passes through the fluid of the cochlea and strikes the lamina spiralis, which intensifies and transmits the vibration to the system of rods. There is doubtless a rod, not only for each tone or semitone, but even for much more minute subdivisions of the same; to

that every sound causes its own particular rod to vibrate, and this rod vibrating, causes the nerve-cells in connection with it to send a nerve-current to the brain.—*Nature.*

Death of Von Mohl.—We have to record the death of *facile princeps* the most eminent of vegetable physiologists, Prof. Hugo von Mohl, which took place on April 1st at Tubingen. Von Mohl was born at Stutgart in 1805, and in 1835 was appointed Professor of Botany and director of the Botanic Gardens at Tubingen, a position he has held ever since. Conjointly with Schlechtendal, and since his death with Prof. de Bary, formerly one of his pupils, he has been editor of the weekly 'Botanische Zeitung' since its commencement in 1843. He was one of the foreign members of the Linnæan Society, having been elected as long ago as 1837. Von Mohl has been a copious and most accurate writer on subjects connected with vegetable anatomy and physiology, of which he may be said to have laid the secure foundation in his early investigations of the true relation of cell-membrane and contents. Among his original observations we may especially mention his essay on the Structure of Endogens, published by von Martius in his 'Historia Palmarum,' and on the Stem-structure of Cycads in the "Vegetable Cell," which appeared in Rudolph Wagner's 'Handwörterbuch;' on the Origin and Structure of Stomates; on Cuticle; on the Structure of Cell-membrane; on the Structure and Anatomical relation of Chlorophyll; on the Multiplication of Plant-cells by division, and numerous other essays collected in his 'Vermischte Schriften.'

PROCEEDINGS OF SOCIETIES.

Dublin Microscopical Club,

January 18th, 1872.

Rev. E. O'Meara submitted for inspection three forms of the genus Tryblyonella closely resembling each other in character of the striation:—1, *Tryblyonella Hantzschiana*, Grunow, narrow-lanceolate with pointed apices; 2, *T. Victoriæ*, Grunow, linear, rounded suddenly at the end, much shorter and relatively broader than the former; 3, a form longer and narrower than *T. Victoriæ*, with the ends pointedly arched. He remarked that he had found the two former not unfrequently in fresh water—for instance, *T. Hantzschiana* in a marlhole in the South of Co. Wexford, and *T. Victoriæ* in Lough Neagh, far from marine influences, though both had occurred sparingly in brackish localities. No. 3 had never been found by him in fresh water, but in several places within reach of the tide. Taking into consideration the localities in which he had found the form, as well as the peculiarities of outline invariably exhibited, he thought it was likely a distinct species, and was provisionally inclined to regard it as such under the name of *Tryblyonella subsalina*.

Dr. Macalister exhibited some scales from the pelvic shield of *Chlamydophorus truncatus*, showing the component scutes of that portion of the animal's integument to consist of large polygonal cells of squamous epithelium of uniform size, the deeper cells being thicker and softer.

Mr. Archer exhibited a fine living Gromia, obtained from one of the Connemara gatherings in autumn last, well showing its characteristic extremely long, copiously arborescent, and reticulated pseudopodia, with the active circulation of granules carried along by the currents of sarcode. This might possibly be no very important addition to the list of Rhizopoda found in the Connemara gathering already mentioned in these Minutes (Oct., 1871); but this form was at least to him one of rare occurrence, although from the mode it is sometimes referred to in different writings, one might assume it was sufficiently common; yet its being so seldom encountered by him may be possibly due to his searches being in situations not this form's favorite habitats.

Professor Traquair exhibited on the part of Mr. Carruthers (who kindly forwarded it for the occasion) a preparation of a singular organism discovered by him in making sections of

Lepidodendron, and as yet supposed to represent the "skeleton" of some fossil form of Radiolarian, consisting, as it appeared to do, of a hollow-globular structure of apparently "spongy" or fibrous character, here and there externally elevated into somewhat conical projections, from nearly all of which latter proceeded an elongate rather tapering slender process sometimes bifid at apex, these standing out radially in every direction. It might be said the whole had thus a somewhat "Xanthidium"-like appearance (like the similar objects in flint) or that of the Zygospore of certain Desmidieæ. The true nature of this remarkable minute fossil form would appear to be doubtful, but the resemblances would seem for the present probably to point most strongly in the direction of the Radiolaria. We understand that Mr. Carruthers proposes to publish his investigations on this interesting point, to which he has given the name *Traquairia*, recognising it as a new genus of Radiolarians.

Mr. Thiselton Dyer exhibited to the Club the asci of *Bulgaria inquinans*, Fr. These are easily demonstrated by taking a minute portion of the black velvety disk of the fungus, and gently compressing it with a little liquefied glycerine jelly under a thin glass cover. The asci are spread out in elegant purplish rosettes. Each ascus is slender and club-shaped, containing at first the rudiments of eight spores, of which about four come to maturity, and are then seen obliquely arranged in a row within the ascus, and well contrasted with it from their deeper colour. These points were worth noting, because the figure given by Cooke in his 'Handbook of British Fungi' stood in need of correction; the figure of Tulasne ('Ann. Sc. Nat.,' xx, t. 15, f. 5) which Cooke quotes is quite accurate.

Mr. Thiselton Dyer called attention to a paper read by Mr. Cooke at the Quekett Microscopical Club on November 24th last (see 'Nature,' vol. v, p. 134) on the combination of the genera *Gymnosporangium* and *Podisoma*. At a former meeting Mr. Thiselton Dyer had expressed an opinion as to the unsatisfactory nature of their distinctions; he thought there could be no doubt that Mr. Cooke was right, and wished that he had united the genera in his handbook.

Mr. Thiselton Dyer showed a good example of *Pilobolus crystallinus*, Tode, for which he was indebted to his friend Mr. Carruthers. It was a species which might reasonably be expected to elude the observation of all but ardent fungologists.

Mr. Thiselton Dyer showed "Tylose dans la vigne," a preparation which he had obtained from Prof. Van Heurck, of Antwerp. It was one of a numerous class of puzzling things, pretty generally known, but never mentioned in text-books. The so-called "tylose" is a vesicular mass of large cells which entirely fills the cavities of the old ducts. It was a histological problem which he wished to submit to the Club:—What is the origin and history of this secondary tissue? Mohl supposed ('Reports of Ray Society,' 1849, p. 27) that the cells were, so to speak,

hernioid protrusions of the walls of adjacent cells through the finally pervious pores of the ducts.

Mr. Thiselton Dyer wished, lastly, to show *Exobasidium vaccinii*, Wor., a plant which he believed he had first announced as British ('Journal of Bot.,' vol. ix, p. 328). It was according to Woronin a true Hymenomycetal fungus, and had been carefully worked out by him in the 'Berichte u. d. Verh. d. naturh. Ges. zu Freiburg im Breisgau,' vol. iv, pp. 397—416, tt. v—vii. The preparation having been made from dried specimens was not very satisfactory or altogether accordant with Woronin's figures. The question indeed suggested itself whether similar external characters in this plant did not conceal a polymorphism of ultimate structure.

15th February, 1872.

Dr. Moore showed some examples of a globose green "unicellular" alga; the cells were large, but showed themselves of various sizes, and there was evidence that a process of internal "breaking-up" of the contents took place, assuming a somewhat radiate arrangement and then probably set free. The water around abounded with zoospores, very much resembling in the appearance and characteristics of their contents the component portions of the contents of the globose cells, and the conclusion was very strongly suggested that they were phases of one and the same thing. The zoospores finally germinated, though none had presented themselves forming filaments of as yet more than two or three minute joints, these very closely resembling those of a minute short-jointed filament occurring in the same water; viewed in this light each of the large globose cells (forming, indeed, a pretty object) would be probably more correctly regarded as a "sporangium" than as an independent alga. Dr. Moore hoped still further to have an opportunity to watch this growth, which periodically presented itself in the tanks at the Botanic Garden.

Rev. E. O'Meara exhibited a new Mastogloia (which he proposed to call *Mastogloia binotata*), and of which a full description would shortly appear.

Mr. Keit showed the fungus *Speira toruloides* (Corda), obtained in the botanic garden, occurring on *Coccoloba macrophylla;* it was afterwards found on a decaying Pitcher plant, *Nepenthes Hookeri*, in close proximity to the Coccoloba. This fungus ordinarily grows on the oak; this appears the first record in this country.

Mr. Crowe exhibited examples of some water taken up near the Cape of Good Hope, which at the time was remarkable for its red colour and mucous consistence. The water now appeared to be pervaded by multitudes of empty skin-like, somewhat shrivelled, and colourless coats, as if they had been once round in figure; and the question became of what were these the remains, and if to this organism the red colour, when fresh, was due? The pre-

valent idea was, these shrivelled membranous, sac-like skins must be the remains of Noctiluca, though the gentleman who made the collection had not recognised any phosphorescence.—Mr Crowe likewise showed spicules of "Venus's Flower-basket," obtained from an example given to him by the same gentleman.

Dr. Macalister exhibited the hairs of *Galeopithecus volans*, showing that they are of similar structure to those of Insectivora, and do not in any respect resemble those of the Cheiroptera.

Dr. E. Perceval Wright exhibited preparations of the curious foot-like appendages met with in the *Peripatus Huttoni*—a new species of this remarkable genus, sent by Captain Hutton, a corresponding member of the club, from New Zealand. It was the first species of this genus discovered in New Zealand. Perhaps the most satisfactory figures of the details of structure met with in the genus were those of Grube, in the "Novara Reise," and yet, in reference to the feet and their curious hooked claws, they still left something to be desired. Dr. E. P. Wright expected some fresh specimens from Captain Hutton, which might, perhaps, throw some light on the variety in the number of the segments constituting the bodies of these annelids.

Mr. Archer showed several Desmidieæ from the Galway gatherings, also Tatem's new Melicerta (a beautiful object); and, ere the meeting broke up, further drew likewise the Club's attention to a recent paper by Professor Max Reess (in 'Monatsbericht der Akad. der Wissensch.' Berlin, October, 1871), conveying an account of certain experiments by him in "sowing" the spores of Collema on the substance of Nostoc, thereby, as the author inferred, converting the "Nostoc" into Collema. This paper Mr. Archer had only just seen, and had been much interested thereby; it served to recal to recollection an example of a little Nostoc, bearing indubitable "spores," not long since brought by him to a meeting of the Club, but, owing to press of matter, not exhibited, and which somehow had been since omitted even to be recorded; he would, however, take a subsequent opportunity to draw attention thereto in a separate Paper, and at the same time venture to refer to the memoir of Reess more at large.

21*st March*, 1872.

Mr. A. Andrews exhibited living examples of *Bosmina longirostris*, and of *Lynceus elongatus*, from Clonhugh Lake, near Mullingar.

Dr. John Barker showed fertile examples of *Œdogonium echinospermum*, the antheridia, not, as ordinarily the case, seated on the cell supporting the oogonium, but further down, here and there, along the filament.

Dr. Moore exhibited a moss from New Zealand showing the peculiarity in the cells of the leaves of an internal arrangement, bearing some faint resemblance to the reticulate structure of those in Sphagnum, but not constituting the real parenchymatous tissue, as is the case in that genus.

Rev. E. O'Meara exhibited some specimens of *Melosira varians* in which the endochrome-plates were very obvious even when the frustules were fresh; in the case of others, treated with dilute hydrochloric acid, the "plasm-sac" surrounding the sunk-in cell contents were composed of large somewhat oval granules, and in no case did they exhibit the stellate appearance described by Pfitzer in his paper in 'Ueber Bau und Entwickelung der Bacillariaceen,' t. vi, f. 5, 6, 7.

Mr. Crowe showed *Staurastrum sexcostatum* from the little Stephanosphæra-pool on Bray-Head, this desmid being for the first time noticed in that very restricted station.

Mr. Archer was at last fortunate enough to be able to present fine active living examples of the singular little animalcule recorded already by him, but not before able to be exhibited, *Drepanomonas dentata* (Fresenius). He was also able to show *Cœnomorpha medusula* concurrently, once before exhibited to the Club. Both are sufficiently interesting on account of their singularity of form, and may, he thought, be regarded as decidedly rare. Mr. Archer likewise showed a pretty copious gathering of the apparently rare little alga *Sciadium arbuscula* (A. Braun). Its (no doubt) "relative," *Ophiocytium Agardhianum minus* (Näg.), is on the other hand common, but the form *majus* is seemingly rare.

Dr. Macalister showed preparations of the mucous membrane of the tongue of *Chlamydophorus truncatus*, showing the long recurved filiform papillæ and the rounded smooth fungiform eminences, covered with squamose epithelium; some of the former were divided at the summits, and were longer around the edges of the tongue.

Rev. E. O'Meara read a translation by him of a communication from Judge Môuchet, Rochfort-sur-mer, France, on Illumination, and gave notice that he would propose that gentleman (who was seconded by Dr. Barker) as a Corresponding Member of the Club on the next night of meeting.

East Kent Natural History Society.

President, the Rev. John Mitchinson, D.C.L., &c., Oxon.; Honorary Secretary, George Gulliver, F.R.S., &c.

April 4th, 1872.—*Land and freshwater shells in the neighbourhood of Dover.*—Dr. C. A. Gordon, C.B., Deputy Inspector-General of Army Hospitals, having taken advantage of his station at Dover to examine these shells, of which he had exhibited specimens to the meeting, communicated a formal list of them, as follows:—Succinea putris, S. elegans, Zonites alliaria, Z. nitidulus, Helix aspersa, H. arbustorum, H. nemoralis, H. cantiana, H. carthusiana, H. virgata, H. rufescens, H. hispida, H. rotundata, Bulimus obscurus, Planorbis complanatus, P. spirorbis,

Lymnæa stagnalis, L. palustris, L. glutinosa, Ancylus fluviatilis, Bythinia tentaculata, Cyclas cornea, Cyclostoma elegans. Dr. Gordon considered the term "Models of Creation," as applied by the late Dr. Mantell to fossil shells, peculiarly appropriate, and gave some interesting and instructive observations on the poetical, popular, and historical associations connected with shells.

Coast Museums.—On the mention of an intended museum of natural science at Eastbourne, Mr. Gulliver gave an account of his views concerning what should be the true object of such collections, and of the absurd errors too commonly exemplified and committed therein; and especially as to the easy means by which museums on the sea coast might be made subservient to the best kind of instruction on marine botany and zoology; and how the numberless microscopes, now employed to little profit, might be at once and for ever, even by unskilful persons, used for the advantage of science and their own intellectual culture. And this question has since been well ventilated in 'Land and Water,' May 11, 1872.

Economy of the freshwater Polyp.—Mr. Fullagar, who has for years kept in his aquarium many specimens of *Hydra vulgaris* and *H. viridis*, communicated a paper on the habits and economy of these creatures, illustrated by numerous drawings (since engraved in 'Science Gossip,' June, 1872). He had, by numberless experiments, proved the accuracy of Trembley's observations on the rapid multiplication of hydras when artificially divided; and he had further observed on the hydras in December whitish tubercles, these containing myriads of animated particles too minute for satisfactory examination by a low objective, though under one of a tenth of an inch focus they presented all the characters of spermatozoa. During their appearance the hydra ceased to take food, and the seminal matter was often squirted forcibly from the tubercle; the parent hydra would then vanish, probably from death and decomposition; and in the following spring some minute hydras would appear in the water, grow freely, and multiply by buds. He gave good descriptions of their manner of feeding, and of how easily they may be collected and kept to afford very interesting subjects for microscopical inquiry.

April 18th, 1872.—*Archegonia and Antheridia.*—Of these, Mr. Down gave some demonstrations in *Polytrichum* and other mosses, showing how easily and instructively the sexual fructification of these plants may be examined even by low microscopic powers, as the examinations were all made extemporaneously, with the assistance of the several microscopes at the meeting, on fresh specimens collected during the afternoon by Col. Horsley and other members.

May 2nd, 1872.—*Objects simulating human workmanship found in the Suffolk Crag.*—These were chiefly sharks' teeth, mentioned as belonging to the genera *Otodus* and *Carcharadon*, and having formed part of a series of such objects in the possession of

Edward Charlesworth, Esq., F.G.S. Between the fang and crown of each tooth was a hole, like in form and position to that made in such teeth at the present day by the South Sea Islanders, in order to the fabrication of necklaces. The objects were all described as from the Suffolk Crag, and, as they were sent to the meeting by the Rev. W. Bird, without sufficient description or time to prepare any connected account of them, Dr. Mitchinson gave an extemporaneous address on the points at issue. These were the means by which the perforations were made, and their significance however or whenever made; if by man, contemporaneously with the formation of the Suffolk Crag, it would carry his antiquity back most wonderfully. But, admitting the holes to have been the result of human agency, it would then have to be determined when and how the teeth had got into that Crag; and, on the other hand, considering the siliceous teeth of certain mollusks, and the well-known perforations made through very refractory substances by other invertebrates, the precise significance of these perforated sharks' teeth would require more exact inquiry than could be afforded by the meeting.

A Plague of Ticks.—Colonel Cox brought this important question in an initiatory manner before the meeting, as he intended to revert to the subject soon. He and Mr. Dowker described these ticks as arachnids, occurring on sheep and lambs in dense patches as big as a saucer, more scantily on young pheasants, and occasionally on ferrets, but seldom on dogs. The effects on the flocks and on the pheasants were so extensive and dreadful as to strike aghast the bucolic and sporting minds. There were two very different sorts of this tick—one bloated, of a leaden colour, with red legs and occipital plate, and about as big as a small horsebean; the other altogether red, not at all bloated, and scarcely a tenth of the size of the big specimens. Both sizes are found on the sheep and lambs, but the biggest most numerously. The little flat red ticks occur besides very plentifully in pastures, as well as on or under the bark of trees and bushes. Dr. Kersey confirmed these statements from his own observations; and Mr. Gulliver displayed, by dissections under the microscope, the testes and spermatozoa, and the ovaries and ova, so as to show that all the large bloated ticks were pregnant females, while the males were found exclusively among the small red specimens. The ravages of this tick were described as most destructive at Bifrons, Broom Park, and elsewhere about Canterbury, as well as in other parts of Kent.

Orchis fusca, Neottia Nidus avis, &c.—Mr. James Reid exhibited fine blooming specimens of these plants, gathered on the 29th of April, and remarked that this was probably an earlier notice of the full bloom of the former orchis than had yet been recorded. He also produced truly wild examples of *Polygonatum officinale* and *Convallaria majalis*, both collected in the neighbourhood of Canterbury.

Water-beetle and Nest.—A female of *Hydrophilus piceus* and

her nest, or rather silk-like cocoon of eggs, were shown in one of Mr. Fullagar's vases; and the manner in which this insect forms the cocoon, for the protection of the eggs, was explained by him with the aid of illustrative drawings.

Raphides of Dictyogens.—Mr. Gulliver gave extemporaneous demonstrations of these in fresh plants of *Paris* and *Tamus*, and remarked that in the British flora all the plants of this section are sharply defined by the raphidian character from the immediately preceding and succeeding orders of the so-called natural system; but further observations are required on exotic Dictyogens. He had found raphides abounding in *Lapageria*, *Testudinaria*, *Sarza* and *Dioscorea*, but replaced in *Roxburgia* by crystal prisms ('Quart. Journ. Micr. Sci.,' January, 1866, and July, 1869). Different tubers are sold at Covent Garden as "yams;" these are beautifully distinguishable by the raphides in one kind, which is a *Dioscorea*, from another kind which has no raphides, and is a member of the order Convolvulaceæ. Now, the Yams have been shown to possess, in some important points of structure, a resemblance to the Birthworts; but if we compare the abundance of raphides in *Dioscorea* and *Tamus* with the total absence of these crystals in *Aristolochia*, we shall immediately see a remarkable difference not yet noticed in the books of systematic botany.

May 11th, 1872.—*Well-boring at Sturry.*—Colonel Cox read a paper showing that at a depth of from 15 to 19 feet they came to the blue clay, which continued down to 40 feet; and at from 46 to 50 feet a water spring was struck.

The Plague of Ticks.—Colonel Cox, referring to the proceedings on this subject on May 2, read an elaborate paper concerning the Ticks, now so fearfully injurious to the flocks of sheep and the young pheasants of the neighbourhood. By the Rev. H. G. W. Aubrey and the Editors of 'Land and Water,' the Tick was pronounced to be *Ixodes Dugesii*. The Colonel detailed many interesting facts from his own observations, and these were confirmed by the parallel inquiries of Dr. Kersey, Mr. Dowker, and Mr. Gardner; the latter gentleman's flock having suffered severely from the pest, while he had endured much anxiety and expense in remedial means.

June 6th, 1872.—*Scropularia vernalis, Aceras anthropophora, Lepidium Draba, Statice reticulata*, and *Saxifraga longifolia.*—Mr. James Reid brought fresh plants of the Yellow Figwort, collected in the vicinity of Canterbury, and supposed to be new to the Kentish flora. The Rev. President, Dr. Mitchinson, while casting no doubt on the wildness of the present specimen, remarked that much caution should be used concerning such cases; for, after having himself found this very species abounding near Peterborough, he had learned that a botanist had been in the habit of sowing scarce plants in that neighbourhood. Mr. Reid noticed the unusual abundance of the Green Man-orchis near Canterbury during the present season. The Whitlow Pepperwort was described by Mr. Gulliver as very plentiful in fructification on

the West Cliff, at Ramsgate; whereupon Dr. Mitchinson observed, that it would be interesting to note whether it would maintain its existence there, as many strayed or introduced plants, though flourishing for awhile, sooner or later perished, as he had seen remarkably exemplified in the common Virginia Stock and other plants. Specimens of the Matted Thrift, collected by George Gulliver, jun., between Dover and Folkestone, were laid on the table. Dr. Mitchinson, having transplanted a young *Saxifraga longifolia* from its mountain home in Switzerland to a pot in his own garden at Canterbury, found it flourish and bloom admirably, like so many other members of this genus.

Plant Crystals.—Mr. Gulliver, referring to his communication to the Society, September 14th, 1871, gave extemporaneous demonstrations of the sphæraphides of the two British species of *Mercurialis* and of *Viburnum Lantana*, remarking that these are good native plants in which to examine the sphæraphides, and that they may be found abundantly in our indigenous Urticaceæ, Chenopodiaceæ, and many other orders; while the willows, poplars, and many other trees or shrubs, afford plentiful crops of minute crystals of another kind, which are too often incorrectly called raphides. A slide was shown of *Pandanus*, from Professor Thiselton Dyer, in which was well seen chains of cells, each cell containing a prismatic crystal, as discovered by Professor Dyer, the chains surrounding the fibro-vascular bundles. Pandanaceæ is an order long since characterised by raphides; but the crystals now shown in Professor's Dyer's preparation are of a different form, as described and figured by him in the last vol. of the 'Quart. Journ. Micro. Science.'

Notes on Ixodes Dugesii.

Experiments of Dr. Kersey.—This gentleman detailed a series of experiments as to the effect of different reagents in the destruction of these pests, and had not yet arrived at any very satisfactory result. The usual nostrums called "sheep-dips" were all more or less ineffectual. The mercurial liniment of the Pharmacopœa and Brandish's solution of potass seemed to be most destructive to the parasites; but their tenacity of life is so great and their absorbent powers so little, that they are not easily destroyed by specifics. Mr. Gardner, whose practical experience had unfortunately been so great, concurred with Dr. Kearsey.

Anatomical and Physiological Observations.—These were undertaken, at the request of the meeting, by Mr. Gulliver; and some of the results are noted below, from the examination of numerous specimens supplied by Colonel Cox, Mr. Gardner, Mr. Dowker, and Mr. Bell. All the specimens were eight-legged Acarina, belonging to the family Ixodea, and, as asserted, to the species *Ixodes Dugesii*. No eyes could be detected.

Sexes.—All the large, lead-coloured specimens were pregnant females. Many of the small ones were also females, but these were commonly of a lead colour, and not red, except in the legs and

plate at the back of the head. In many ova the large germinal vesicle and its single spot or nucleus was plainly seen. As to the males, they occur abundantly, and sexually mature, among the little red specimens so numerous on pastures and trees or shrubs. The spermatozoa are pale, quite homogeneous, nearly transparent, arcuate, sharp at one end, and blunt or truncate—not clavate—at the other; length 1-185th of an inch, thickness 1-6400th. They disappear when treated with acetic acid, and cannot be made to dry well; in both these respects, as well as in others, differing from the spermatozoa of insects and mammals. The testis is a bunch of vesicles much like the ovary.

Eggs.—Some of the large females, after a few days' confinement in a tin box, deposited there many ova, feebly sticking together in clumps often as large as the parent ticks. These eggs were smooth, of a glistening chocolate colour, oval in shape, and each about 1-40th of an inch long and 1-60th broad. Their shell was composed of chitine; its contents chiefly of corpuscles, some globular, more of the same form as the shell, and presenting an average length of 1-500th and a breadth of 1-727th of an inch; each distinct in outline, and all generally larger and more regular in size than common yolk granules. The number of ova was so great as to show the prodigious fecundity of these ticks, as, indeed, is too well known to the flockmasters of this neighbourhood.

Urinary Apparatus.—This is greatly developed, consisting of two transparent tubes, easily recognisable by their opaque white contents, having all the properties of guanine, and never showing any trace of uric acid. In the more common sheep-tick, which belongs to the hexapod insect-order Diptera, and is the *Melophila ovina* of Nitzsch, and which was examined at the same time for comparison, uric acid was always found. Thus these two creatures, both living on the selfsame sheep, have their urinary matter so essentially different. And in the excrement of every insect and spider examined the same difference was found, corresponding to the observations made on scorpions and true spiders many years since by that eminent physiologist John Davy. And this important physiological character, now extended to the Acarina, though not yet recognised in the books of the zoological taxonomy, should fine a place there. The same holds good of *Argas* (described as British in the 'Quart. Journ. Micro. Sci.,' April, 1872), in which species the urinary granules are opaque, white, smooth, shining, concentrically striated, more or less globular or oval, with an average diameter of $\frac{1}{1201}$th of an inch, and often two partly fused together. They present a truly beautiful microscopic spectacle, especially when examined in clusters within the urinary tubes. In *Ixodes* the urinary granules are not so large and remarkable as in *Argas*. The urinary tubes in both commence by a blind and sub-clavate extremity at the fore part of the body, and proceed tortuously backwards to open into the last portion of the intestine, where is a bilobed sac,—a sort of urinary bladder, most distinct in *Argas*.

Feet and Progression against Gravity.—The smaller specimens of these ticks may be often seen crawling, like flies and some other insects, up and under the sides of polished surfaces. This is done by means of the caruncles, one of which is situated between each of the pair of hooked and terminal claws, on their concave side. When the creature has the claws free, each caruncle presents a crescentic shape, but the moment it is applied to the glass or other smooth surface the caruncles become adapted to it, and assume the form of round flattened disks. All this may be well seen with the half-inch objective, when the *Ixodes* is walking on the glass object-slide, by an examination of the action on both sides, *i. e.* either from the ventral or dorsal aspect of the animal. As no mark of viscid matter is then perceptible, it is probable that atmospheric pressure produces the effect. *Argas* is devoid of such pedal structure.

Queen-bee Jelly.—The eminent apiarian Major Munn, having sent specimens of queen-bee cells, with their contained larvæ and jelly (or "bee bread"), from four to eight days old, Mr. Gulliver undertook to examine it. The colour of the jelly was whitish, its consistence pulpy, its taste somewhat sharp and sweetish. It reddened litmus; was miscible with water, and assumed an opaque white colour with alcohol, sublimate, nitric acid, and heat. Acetic acid produced no effect, but caustic potass very quickly and completely dissolved it, and the solution was instantly precipitated on the addition of acetic acid. There was no trace of gelatine in the jelly; it soon dried into an amber-like solid, but became white and pulpy, as it was originally, when soaked in water. Morphologically, the jelly was partly composed of a very fine molecular base, like that of mammalian chyle, the molecules much alike in size and form, and measuring each about 1-30,000th of an inch in diameter; but the molecules, being completely insoluble in alcohol or ether, differ from those of chyle.

It is not a little remarkable that this queen-bee jelly, though undoubtedly of very high importance in the economy of this most useful insect, is not even mentioned, much less described, in the great books of animal, organic, or physiological chemistry. When noticed in other works, it is but perfunctorily, and in a manner to indicate a collection from pollen or other parts of plants; and it was seen by Mr. Gulliver to contain a few pollen-grains, some almost perfect, others disintegrated, but altogether insufficient to form the essential composition.

But, now, this is plainly proved to be one of the albuminoid group, affording an abundance of Mulder's protein, highly nitrogenized, and with a molecular base, the whole evidently a true animal secretion and by no means a mere collection. And thus the queen-bee jelly is exactly such a nutrient matter as may be rationally supposed most conducive to the growth and development of the larva, just as milk is to young mammals, and the ingluvial secretion of certain birds to their nestlings.

MEMOIRS.

On the NATURE *of the* CUTICULA DENTIS (NASMYTH'S MEMBRANE). By CHARLES S. TOMES, M.A. Oxon., Lecturer on Dental Anatomy and Physiology at the Dental Hospital of London. (With Plate XVII.)

SINCE it was discovered by Nasmyth that by the use of acids a membrane could be raised from the surface of the enamel in a perfected but as yet unworn tooth, numerous and irreconcilable views have been propounded as to its nature and homologies. Nevertheless, if the preparations which serve to illustrate this paper are to be trusted, the theories of its origin which are set forth in the most recent histological text-books cannot be accepted.

When the crown of the unworn tooth is submitted to the action of an acid a thin membrane peels off the surface of the enamel; this membrane is characterised by its great power of resistance to the action of reagents, and, when burnt, gives off a smell like that of burning horn, leaving behind it a spongy ash.

By Professor Huxley it was considered to be identical with the membrana preformativa of Raschkow, whilst Professor Kölliker[1] holds that it is merely a continuous layer round the exterior of the enamel, which has been shed out by the enamel-cells in common after the completion of the separate enamel-fibres; in other words, that it is a sort of varnish furnished by the enamel organ as a finish to its work of forming the fibrous enamel. This similar origin has been ascribed to it by Professor Rolleston[2] who speaks of "the "*cuticular dentis*" being the last result of the process of induration, as taking place in the enamel organ."

In the opinion of Waldeyer,[3] Nasmyth's membrane is derived from the external epithelium of the enamel organ, the cells of which become closely applied to the surface of the enamel after the enamel-prisms are completed in length, and he believes that these cells become cornified.

[1] Kölliker, 'Handbuch der Gewebelehre,' 5th Aufl.

[2] 'Transactions of the Odontological Society,' June, 1871. Report of discussion, vol. iii, p. 245.

[3] Stricker's 'Handbook of Human and Comparative Histology.' Sydenham Society's Translation.

In support of this idea the fact that, by staining with nitrate of silver, outlines resembling those of epithelial cells may be brought out, is adduced.

I am, however, unable to reconcile the appearances observed with these hypotheses as to its origin; and the object of the present paper is to endeavour to prove the substantial correctness of a widely different view, not, indeed, new, since it was advocated by Professor Owen[1] and by my father[2] many years ago, and has been accepted by Professor Wedl,[3] but one which has apparently been to some extent over-looked, or, at all events, has not gained general credence. The preparations at my disposal appear to me to prove conclusively that the membrane is no way referable to the enamel, but that it is nothing else than coronal cement; that it is, in fact, the homologue of the thick coronal cement of herbivora.

In the first place, it may be mentioned that a comparison of the tooth-sacs of man with those of the herbivora reveals no anatomical reason why there should not be coronal cement on human teeth, as the histological elements present in the one are also to be distinguished in the other.

Indeed, it now and then happens that a deposition of well-formed cementum actually does occur on the crown of a human tooth. In the bicuspid tooth, a section from which is represented in fig. 1, the cement of the fang ends at the normal position around the neck of the tooth, where the enamel commences. On one side of the crown there is, however, a roundish patch from which the enamel is entirely absent, its place being taken by a thick deposit of cementum.

When, however, the enamel (*a*) recommences at a point higher up on the crown of the tooth, the cement does not at once cease, but is continued for some little distance, as a thick layer containing lacunæ (*e*), outside the enamel. That this deposit of cement in the midst of the enamel existed from the first formation of the tooth, and was not due to absorption of the enamel and subsequent deposition of osseous structure in its place, is proved by the disturbance in the direction of the dentinal tubes which is noticeable at this point (*d*).

Strongly marked cementum, such as that represented in fig. 1, is seldom met with on the crowns of human teeth; if, however, vertical sections be made through the crowns of a large number of human molar and premolar teeth, deep

[1] Art. "Odontology," 'Encyclopædia Brittanica.'
[2] J. Tomes, 'A System of Dental Surgery,' 1859, p. 272.
[3] 'Pathologie der Zähne,' 1870.

fissures will often be found extending down from the grinding surfaces through half or more of the thickness of the enamel. These fissures, which are generally contracted at their orifices, are seldom found empty, but are usually tenanted by a dark brown mass, the structure of which is rendered indistinguishable by its opacity.

In some instances these dark masses are more transparent, and are seen to be made up of round or oval bodies closely packed together, in the centres of which are very commonly dark radiated forms exactly like bone-lacunæ. They are almost always of brownish colour, and the branched air-containing spaces in their centres vary in size and form from mere fissures to full-sized lacunal cavities.

In fig. 2 a single one of these bodies is represented occupying and filling up a minute depression on the enamel of a molar tooth, whilst in fig. 3 a cluster of them is seen lying against one side of a much larger fissure in another tooth. In fig. 4, which is a transverse section through a cylindrical pit in the enamel, a similar large cluster of these peculiar bodies is seen. Out of thirty-six deeply fissured teeth I was able to distinctly see these forms in twelve, while indications of their existence were seen in several others, so that they are by no means uncommon.

No one can look at these bodies without being struck with their close resemblance to the lacunæ of bone, or rather to those of cementum; and when they are compared with those encapsuled lacunæ which are so common in the thick cement of herbivora, and which also occur abundantly in human cement when thickened by disease, the resemblance is seen to be complete. For the sake of comparison, a figure (fig. 5) has been given of these encapsuled lacunæ occurring in the thickened cementum of a human tooth, and these are to be regarded, as Drs. Beale and Waldeyer have pointed out, as remains of the formative osteoblasts, the contours of which, under ordinary circumstances, become lost during the progress of calcification.

The very frequent occurrence of these "encapsuled lacunæ," or "osteoblasts," wherever a deep fissure affords sufficient space for their development, having been noted, it remains to show their connection with Nasmyth's membrane. An unworn molar or premolar tooth, the grinding surface of which shows indications of a deep fissure, having been selected, longitudinal sections through the crown and fang are to be rubbed down on a hone until sufficiently thin for examinations with a half-inch objective. The section is to be laid on the slide and treated with dilute hydrochloric

acid (1 part to 10 parts water); as the enamel dissolves away Nasmyth's membrane will be seen to detach itself from the surface; so soon as this has taken place the acid is to be removed with blotting-paper, and the section very carefully washed so as not to disturb the relative position of the membrane and the tooth, and, after drying, mounted in Dammar varnish. If the manipulations have been carefully conducted a preparation like that represented in fig. 6 will be the result.

In this specimen the enamel (*e*) is partly dissolved away, whilst Nasmyth's membrane (*a*) is seen but little moved from its original position; at the upper and right-hand part of the figure it is seen to be continuous and identical with the dark contents of a deep fissure in the enamel (*d*); previous to the application of the acid no histological characters could be made out in the mass, owing to its great opacity, though the shape and size of the fissure would lead to the expectation of finding lacunæ in it. On tracing the membrane down the surface of the tooth it is seen to be torn in one place, though none of it has been lost; the lower fragment (*a′*) is seen to pass without break of continuity far below the neck of the tooth, where the ordinary cement (*c*) exists.

But it will be observed in the figure that, although the cement is at this part of the tooth very thin, it is not the whole thickness which is continuous with Nasmyth's membrane; and this is more noticeable in the specimen itself, in which the membrane, as well as the outermost portion of the cement, has a yellowish tinge.

If a section be made of the calcified portion of the tooth of a calf at that time when the enamel has just attained its full thickness and the deposition of cement upon it is about to commence, and the section be treated with acid in the manner described, a membrane precisely similar to Nasmyth's membrane in the human tooth peels off; but if a somewhat older tooth be selected, in which the coronal cementum has attained an appreciable thickness, no membrane is made to peel off from its outer surface. The explanation of this fact is obvious: when the structure in question is attached only to enamel it is set free by the action of an acid, seeing that the enamel is absolutely dissolved away, but when it is attached to cementum which is only decalcified, but not dissolved away, it is not set free.

The yellowish colour which characterises Nasmyth's membrane after treatment with acids (particularly with nitric acid) is, however, to be seen *on the outside of the cementum, and not between the enamel and the cementum,* which last position it would hold if it were formed from the

external epithelium of the enamel organ, and which has recently been spoken of by Professor Rolleston,[1] as being represented by the sharp line which limits the enamel off from the cement in such teeth as the incisors of the wombat.

And if any further proof were necessary to disprove this latter hypothesis, it is to be found in the fact that a precisely similar membrane may be raised from the unworn teeth of many fish which have no enamel.

Nasmyth's membrane, then, is continuous, not with the whole thickness of the cementum, but with its outermost layer; in other words, with the layer most recently formed. The rapidity with which it disappears under the influence of mastication, as well as the fact that it is rather deeply tinged by nitric acid, point to its being not very fully, if at all, calcified, an inference which is borne out by its being continuous with the *outermost* portion of cementum. Here the researches of Mr. Rainie,[2] which have been supplemented by those of Professor Harting,[3] throw considerable light on the matter. By the latter observer it has been shown that albumen, in the presence of certain lime salts, undergoes a peculiar modification (to which he gives the name of "calco-globulin"), conferring on it such a great power of resisting acids that he states that it resembles chitin. It is noteworthy that the linings of Haversian canals, encapsuled bone-lacunæ, the sheaths of the dentinal canals, and the youngest layer of enamel, are all structures which have in common a very remarkable power of resisting the action of acids, so that they seem almost indestructible; and they have this also in common, they they lie between perfected calcified structures and the soft tissues from which these are being formed. How far in their chemical nature they may correspond with Professor Harting's calco-globulin must for the present remain an unsettled question; this much, however, seems tolerably certain, namely, that on the border of perfected calcified structures there very generally exists a thin stratum of tissue which presents marked chemical differences from that which lies on either side of it, one of the manifestations of such difference being that great indestructibility which enables us to isolate it by the use of acids.

Nasmyth's membrane appears to belong to this class of structures; it is not exactly perfected cementum, but it is continuous with the outermost, and as yet unfinished, layers of cementum; still, it is homologous with the coronal cementum

[1] 'Translations of Odontological Society,' 1871, vol. iii, p. 245.
[2] 'British and Foreign Medico-chirurgical Review,' No. xl, October, 1857.
[3] 'Quarterly Journal of Microscopical Science,' April, 1872.

of herbivora, inasmuch as this latter, at the period of the commencement of its deposition, exists in a precisely similar form.

This explanation of its nature also serves to remove the difficulty which many persons have felt in accepting Waldeyer's supposition that it was cornified; it certainly did appear exceedingly improbable that a part of the enamel organ should undergo this metamorphosis whilst the remainder was calcified; but if we regard it as tissue which has undergone a peculiar modification preparatory to, or early in the process of, calcification, the difficulty disappears, for such tissues bear no small resemblance to horn in their behaviour, and are to be found, as has been already mentioned, elsewhere on the border of calcification.

NOTES *on* NOCTILUCA. By Prof. ALLMAN, F.R.S., F.L.S., &c. (With Plate XVIII.)

THE occurrence some years ago of *Noctiluca miliaris* in great abundance during the autumn months on the southern shores of Ireland afforded me an opportunity of studying the structure of this singular little animal. The following paper contains an account of the observations then made. These are for the most part confirmatory of the results arrived at by other observers, while in some respects they serve to supplement the researches of those zoologists who have already made Noctiluca a subject of study.

The form of *Noctiluca miliaris* is nearly that of a sphere so compressed, that while in one aspect (fig. 1) its outline when projected on a plane is nearly circular, it is in the aspect at right angles to this (fig. 2) irregularly oval. Occupying about half of one of the meridians of this compressed sphere is the long narrow entrance (*a*) into a deep depression of the surface which I shall designate as the atrium (*b*), while along the opposite meridian there extends a very slightly elevated ridge (figs. 1—3, *c*) of a firmer consistence than the rest of the body, and having somewhat the appearance of a rod embedded in the walls. This commences with the appearance of a bifurcation close to one end of the entrance to the atrium, and terminates abruptly after running over about one third of the circumference of the body. Busch[1] appears to have been the first to call attention to the presence of this rod-like structure, which was again accurately described by Dr. Webb.[2]

[1] 'Beobacht. über Anat. und Entwickl. einiger wirbellos. Seethiere,' p. 103. Berlin, 1851.

[2] 'Quart. Journ. Mic. Sc.,' vol. iii, 1855.

The sphere walls are of crystalline transparency, and the animal measures in its longest diameter in full-grown specimens about $\frac{1}{50}$th of an inch.

From the bottom of the atrium and near to one end of it there springs a long ribbon-like vibratile flagellum (*d*). Here the atrium is very shallow, but towards the opposite end it becomes rapidly deeper. It is just outside this deeper end that the superficial ridge just mentioned commences.

At the root of the flagellum is situated the mouth (*e*), a rather wide aperture in the floor of the atrium. It opens into a short gullet, which leads down into an irregular mass of granular protoplasm situated in the interior of the animal at a little distance from the central point of the body, and immediately beneath the floor of the atrium. Running along the inner side of the gullet walls opposite to the root of the flagellum is the ridge first pointed out by Huxley,[1] which near its middle projects in the form of a tooth into the cavity of the gullet. The gullet further contains a single long cilium first described by Krohn;[2] this springs from its floor and is kept in a state of constant vibration. The floor of the gullet is formed by the central mass of protoplasm, here naked and in direct contact through the mouth and gullet with the surrounding medium. Near the root of the cilium is a depression in the floor which can be followed for a little distance into the protoplasm.

The central protoplasm mass sends off in all directions long, branched, frequently intercommunicating processes of its substance which radiate towards the circumference of the sphere, becoming thinner and thinner as they recede from the centre, until finally, as exceedingly delicate filaments, they reach the sphere-walls with which the extremities of their ultimate ramifications become confluent.

Besides these branching thread-like processes there is sent off from the central protoplasm a broad irregularly quadrangular thin process (figs. 2, 3, *f*), which extends to the superficial ridge, to which it becomes attached by one of its edges; its lower free edge has the form of a thickened border, and at its upper edge it becomes continuous with a plate-like striated structure (*g*), which I believe represents a peculiar duplicature of the body-walls. In contact with the protoplasm mass is a clear spherical body (*h*), the nucleus about $\frac{3}{2000}$th of an inch in diameter.

The sphere walls are composed of two membranes, an external one thin, transparent, and structureless, and an

[1] 'Quart. Journ. Mic. Sc.,' vol. iii, 1855.
[2] Wiegmann's 'Archiv,' 1852.

internal thin granular layer of protoplasm which lines the structureless membrane throughout its whole extent, and which receives the extremities of the radiating processes from the central mass. Under the action of iodine solution and of other reagents the protoplasm layer may be seen to detach itself from the outer structureless membrane, and along with the radiating bands contract towards the centre (fig. 4). It admits of an obvious comparison with the primordial utricle of the vegetable cell.

The flagellum which is given off close to the margin of the mouth is a flattened band-like organ gradually narrowing towards its free extremity. Its axis presents throughout its whole length close transverse striæ. It seems to have the power of elevating its edges so as to render one of its surfaces concave, and thus becomes converted into a semi-tube which may assist in the conveyance of nutriment towards the mouth.

The nucleus is a spherical vesicle with clear colourless contents, among which minute transparent oval corpuscles may usually be detected (fig. 5, *a*). When acted on by acetic acid the difference between the contents and the wall becomes very apparent, and the contents may now be seen contracted towards the centre as a minutely granular mass with some of the oval corpuscles entangled in it (*b*).

The radiating offsets which extend from the central protoplasm to the peripheral layer contain well-defined clear refringent corpuscles (fig. 6), which may sometimes be seen to slowly change their relative places as if under the influence of feeble cyclotic currents. Though these movements are far less marked than the very distinct cyclosis of the vegetable protoplasm, we cannot overlook the close resemblance between the radiating offsets in *Noctiluca* and the protoplasm filaments which extend from the nucleus to the primordial utricle in the vegetable cell. I have never seen anything in the radiating protoplasm filaments of *Noctiluca* which can be compared with the projection and retraction of the pseudopodia in a Rhizopod. The peripheral layer contains scattered through it numerous minute cell-like bodies. These are spherical and of various sizes; in the larger a distinct central nucleus may be detected (fig. 7).

It is scarcely correct to regard the central mass of protoplasm as a true stomach; I have failed in finding any evidence of a permanent gastric cavity, and I regard the protoplasm mass to which the gullet leads as representing the protoplasm of the Infusoria, and, like this, allowing of the solid food being forced down into it from the gullet and encysted there in extemporaneously formed vacuolæ. The food also frequently

forces its way from the central mass into the radiating processes, and diatoms and other microscopic organisms may be seen in these processes enclosed in cyst-like dilatations of them extemporaneously formed for their reception at various distances from the central protoplasm.

I have little doubt that the meridional rod-like ridge described above indicates the course of a canal which opens in a duplicature of the body walls near one end of the entrance to the atrium. This duplicature of the walls appears to have been noticed by Huxley,[1] and is more specially referred to by Webb.[2] It may in certain aspects of the body be seen stretching from the walls of the atrium to the bifurcation of the rod-like ridge, and would seem to open on the surface between this and the neighbouring end of the opening to the atrium. Its sides are marked by transverse striæ. It probably affords an exit for some of the effete residue of digestion which may be conveyed to it through the process which extends between the central protoplasm and the meridional ridge. If I have correctly followed Huxley's account it would seem to be in this region that he also would place the probable anal orifice of *Noctiluca*. It is possible, however, that some of the more bulky insoluble materials may make their way back to the gullet and be then ejected through the mouth. Whether the little depression which is visible in the protoplasmic floor of the gullet can be regarded as a specialised point of entrance or exit I have no evidence to enable me to say.

Numerous brownish-yellow globules resembling oil drops were frequently seen adhering to the outer surface of the central protoplasm mass, and are probably some of the products of digestion which had arrived there by transudation from the interior.

After the completion of the digestive process and the rejection of the solid residue, the central protoplasm may be occasionally seen distended and greatly vacuolated, and the vacuolæ filled with a clear fluid (fig. 8). Clear spherical vacuolæ may also at the same time be seen in the course of the radiating filaments.

Our knowledge of the phenomena of reproduction and development in *Noctiluca* is still very imperfect, and I saw very little which seemed capable of throwing additional light upon this subject. No instance of transverse fission occurred in any of the examples examined, nor did I meet with the swarm spores originally described by Busch,[3] and afterwards

[1] Loc. cit., p. 54. [2] Loc. cit., p. 103.
[3] 'Beobacht. üb. Anat. u. Entwickl. einiger wirbellosen. Seethiere.'

more fully by Cienkowski.[1] It is probable, however, that the nucleated cell-like bodies which are present in the peripheral layer of protoplasm have a reproductive function and are destined after liberation to become developed into new individuals. Huxley notes the presence of "granular vesicular bodies of about $\frac{1}{1000}$ of an inch in diameter scattered over the surface of the anterior and inferior part of the body,"[2] and regards them as possibly belonging to the reproductive apparatus. These would seem to be the bodies which Cienkowski has seen to become transformed into swarm spores.

From the account now given it will be seen that *Noctiluca* is destitute of all trace of a contractile vesicle, and that no cilia are developed on any part of its surface. It consists, in fact, essentially of an enormously vacuolated protoplasm involving a nucleus and enclosed in a structureless sac, which is provided with an inferent and probably also with an eferent opening; the vacuolation taking place to such an extent as to separate the contents into a peripheral layer of protoplasm which remains adherent to the outer sac, and into a central mass which is kept in communication with the peripheral layer by processes of protoplasm which pass from one to the other in the form of a meshwork of branched and intercommunicating filaments.

That *Noctiluca* constitutes a very aberrant type of the great group of the Infusoria must, I think, be admitted. From the typical Infusoria, however, it departs widely. The absence of contractile cavity and of superficial cilia are points in which this divergence is especially obvious. I am scarcely disposed to view the nucleus of *Noctiluca* as representing the so-called nucleus of the typical Infusoria, and I would rather regard it as corresponding to a true cell-nucleus. Indeed, it is difficult not to see in *Noctiluca* the essential characters of a cell which has reached a certain advanced stage of differentiation without losing its original unity.

Among the animals whose position among the Infusoria is generally admitted are those belonging to Ehrenberg's genus *Peridinea*. It is to these that I believe *Noctiluca* bears the closest affinity, closer even than to *Trachelius*, whose affinity to *Noctiluca* has been especially maintained by Gegenbaur. In a little animal examined by myself many years ago,[3] and which comes nearer to *Peridinea* than to any other genus, we have the internal protoplasm with a nucleus all enclosed in a firm structureless external sac, while no trace of contractile cavity could be detected in it. We have, further,

[1] "Ueber Schwärmerbildung bei Noctiluca," 'Schultz's Archiv,' b. 7.
[2] Loc. cit., p. 54. [3] 'Quart. Journ. Mic. Soc.,' vol. iii, 1855.

a deep meridional furrow extending from the pole to the equator, while from the bottom of this furrow, near to its equatorial end, there projects a strong vibratile flagellum. It multiplies itself by transverse fission, the division of the animal being always preceded by that of the nucleus which thus comports itself as the cell-nucleus during cell-division; and, also, as it would seem from the observations of Krohn, and, more especially, of Baddeley,[1] as the nucleus of *Noctiluca* during the spontaneous fission of this animal.

It is true, I have not succeeded in detecting in it a mouth or eferent orifice but I would not, on this account, insist on their absence, and, under circumstances favorable for observation, a mouth would probably be detected at the base of the flagellum. It is, moreover, ciliated on its surface, and is provided with an equatorial as well as meridional furrow, and with an ocelliform spot.[2] Notwithstanding, however, these differences, the relations between *Peridinea* and *Noctiluca* are too close to be overlooked.

There is, perhaps, not one of the phosphorescent animals hitherto examined more eminently luminous than *Noctiluca*, while the vast abundance in which this little animal occurs, at certain seasons, renders it undoubtedly one of the chief sources of the beautiful phenomenon of the phosphorescence of the sea. At such times the sea becomes intensely luminous, while the *Noctiluca* may be then obtained in unlimited quantities by means of the towing-net.

When transferred from the net into a jar of sea water, the *Noctilucæ* soon rise to the surface, where they habitually remain as a thick stratum, while the slightest agitation of the jar in the dark will cause the instant emission of their light. This is of a beautiful greenish tint, and is so vivid that absolute darkness is by no means necessary to render it visible, for even by ordinary lamp light it is quite perceptible. The emission of the light is but of instantaneous duration, and rest is needed for a repetition of the phenomenon. After about a minute's repose, however, the phosphorescence may be excited with as much vividness as before. The little animal also possesses great tenacity of life, and after the slightest

[1] 'Quart. Journ. Mic. Soc.,' vol. v, 1857, p. 185.

[2] It is probable that in every case the cilia of *Peridinea* are confined to definite tracts of its surface. Such appears, at least, to be the case in the species referred to this genus by Ehrenberg. It is further probable that along the ciliated tracts the structureless external sac is deficient, and that the protoplasm is here naked. To suppose that the cilia arise from the outer structureless cell-wall is contrary to all we know of the nature and relations of those bodies.

irritation from other animals which may have been confined in the same jar, have been known to light up for an instant the entire jar with its beautiful phosphorescence. The towing-net which has been employed in its capture will continue, when shaken in a dark room, to exhibit the most brilliant scintillations as long as the *Noctilucæ* which may adhere to it are still alive, and I have seen this phenomenon presented for died, and the water has even begun to exhale a putrid odour, *Noctiluca* may be seen with as much vigour as ever, ready more than thirty hours after the net had been withdrawn from the sea, and when only a slight dampness continued to be retained by it.

Noctiluca differs from *Beroe*, another of the most brilliantly luminous animals of our shores, in the fact that a prolonged withdrawal from sunlight is not necessary in order to render it capable of manifesting phosphorescence; while *Beroe*, as I have elsewhere shown,[1] must be kept in the dark for some time before its phosphorescence can be elicited by any irritation. *Noctiluca*, on the other hand, will show no impairment of its phosphorescent powers even at the moment of its being removed from broad sunlight into a darkened room.

I have satisfied myself that the special seat of phosphorescence in *Noctiluca* is the peripheral layer of protoplasm which lines the external structureless membrane. By a little careful management *Noctiluca* may be examined by night when in the act of emitting its light under the microscope. I have found the addition of a drop of alcohol to the water containing specimens of the animal on the stage to afford a very convenient stimulus for this purpose. The entire surface of the body will then instantly become luminous with a light strong enough for transmission through the microscope with a half-inch object glass. Unlike the momentary phosphorescence elicited by simple agitation, that produced by the irritation of the alcohol will generally last several seconds with full intensity, and will then gradually disappear. Before the final extinction of the light the animal will present the appearance of a luminous ring projected on the dark stage. This phenomenon is at once explained by the supposition that the phosphorescence is confined to the peripheral portions of a transparent sphere, for by this time the light has become so weak as to be inappreciable, except where towards the edges of the projected sphere a greater depth of the luminous stratum lies in the direction of vision.

1 'Proc. Roy. Soc. Edin.,' 1862.

On PEDALION MIRA. By C. T. HUDSON, LL.D. (With Plate XIX).

IN the summer of last year I had the good fortune to find a new rotifer with six limbs, and under the name of PEDALION *mira* I described and figured it in the September number for that year of the 'Monthly Microscopical Journal.' I had not, however, at that time sufficient leisure to investigate its internal structure; and when I had the leisure, the creatures had all disappeared, greatly to my vexation, for on the publication of my paper I had many inquiries about Pedalion, accompanied with requests for a few living specimens. I could only reply that the rotifers had vanished, and that I hoped to find them in another year—an answer as little satisfactory to myself as to my correspondents, especially when it was evident from some of the letters that the writers had a half suspicion that Pedalion was not a rotifer at all, but some Entomostracous larva. I had every reason, therefore, for keeping a keen watch on the pond where I had found these strange creatures. I was certain that they *were* rotifers, for I had seen within them organs very similar to those of Triarthra; still it would be very mortifying not to be able to produce the animal alive to the satisfaction of all inquirers; and again and again did I contrive that my daily walk should take me past the, to me, highly interesting though rather dirty pond, which held my rotiferous hopes.

Imagine my disgust when on one of these rambles I spied a black retriever in a high state of decomposition in the middle of the pond! In a very large body of water it might not have been of much consequence,—that villainous corpse in the Serpentine might have afforded such excellent nourishment as to convert six-legged rotifers into ten-legged ones—but to pitch it into a pond not fifteen feet square! Oh! my Pedalions!

> "What! all my pretty chickens and their dam,
> At one fell swoop!"

For a long time I thought my worst fears had been realised. June came and passed without my finding any but the commonest species. Synchæta seemed to thrive on the generous diet, but not a solitary specimen of Pedalion was to be had, even in the first week in July. So I gave up the search and went down to Ilfracombe; and, as our steamer pitched and rolled through Porlock Bay, I could

not restrain a hope that among the unhappy people at her sides was that miserable canicide who slew Pedalion. It was a hard matter to get over my disappointment; especially as the owners of one or two of my best stocked ponds had lately had most ill-timed fits of cleanliness, had emptied the reservoirs of water stored with the eggs of scores of species, had torn up the water plants which for years had been their haunts, and, worse than all, had scraped off from the sides all the rich growth of algæ that had been so long my happy hunting ground; leaving in lieu of the myriad nooks and corners of the old crumbling joints a vile smooth fresh-plastered surface on which nothing would grow for many a long day. No lover of our old cathedrals could have been more keenly grieved, in the days of churchwardens' Gothic, by the covering up of a worn clustered column in a tidy wrapper of white plaster, than I by these pond improvers. Well may Pritchard say, in his 'Infusoria,' "One remarkable circumstance must be borne in mind by the animalcule-hunter. If he happens to remember a pond where some rare species abounded last year, let him not again turn thither in search of it, as the chances will not be in his favour. These creatures rarely exist in the same water for two successive years."

How could they? When ponds are ruthlessly raked and cleaned, have their walls scraped, and are occasionally treated to dead retrievers, the chances are as much against the Rotifers as the naturalist.

But sometimes a happier state of things exists, and some fair-sized pond (I still know of one), with a gentle stream trickling in at one end and out at the other to keep it sweet, lies embowered in plantations, yet open on one side to the sun, mantled with the leaves of many a healthy water-plant, and undisturbed for years, save by the squirrel dropping the husks of the beech nuts into it, or the water-hen scuttling to its hiding-place as the schoolboy (disdaining the road) forces his way from the field above down through ferns and brambles, to spend his holiday in trying to cozen the lazy carp, who are sucking the weeds and smacking their lips in a hundred places at once.

To such a pond the rotifer hunter may return year after year (as I have done) nearly sure to find all that he has found before, and with the pleasing hope, often gratified, of adding year by year to his list of its minute inhabitants.

In fact, so long as the conditions remain unaltered, why should not the inhabitants? I grant that dead dogs and plasterers *do* affect the pondine population; but it must be

admitted also that they terribly alter the conditions of life for the microscopic races.

At Ilfracombe I renewed my grief by catching in the tow-net among other curious things several specimens of what I supposed to be an Annelid larva, that had at first sight a strange resemblance to Polyarthra, first cousin of Triarthra, and of my lost Pedalion. The large upper circle of cilia with which it swam, and the shoulder-knots of imbricated hairs with which it jerked itself out of difficulties, had a very Polyarthrous appearance: but here the whole resemblance ceased. It was purely one of outward form, and that too not a close one; while, as to internal structure, a simple ciliated mouth, and a uniform alimentary canal running along the mid-line of the body, were poor substitutes for the varied and complicated organs possessed by the Rotifers.

On my return to Clifton early in August I once more took my way to my old haunt, carrying a bottle from habit rather than from hope. I dipped it into the pond at random and almost in the dark, and on reaching home it was with a mingled feeling of delight and regret that I once more saw Pedalion lazily hovering head downwards in the water, as is its wont, and trying apparently to look as much as possible like a young Cyclops.

It was so tantalizing to find the creature again so late in the year when its numbers had already begun to fail, and, moreover, when I myself was so busy that I could hardly hope to find time to study it. Pedalion, too, is a rotifer that especially requires one to have a mind at leisure, as well as a good stock of time, specimens, and patience; for its six limbs bring it into as many troubles (when in the hands of the microscopist) as its antlers did Æsop's stag. When drawn up into a capillary pipette in order to be transferred to the compressorium, it will strike out its unlucky legs just as the water is being blown down the tube on to the glass plate, and there it will be left like the Demerara, a stranded and broken-backed rotifer, that no returning tide will ever fetch off again. Brachionus will often hold on to the pipette with his pincers and suffer the water to be blown away from him, but then he carefully draws himself within his lorica and waits for happier times. Quickly dip the tube into the water and instantly blow through it, and out comes the out-witted Brachionus, who is sure to have let go his hold in his delight at getting afloat again.

Suppose, however, that Pedalion is fairly landed on the compressorium in a tiny drop of water. We screw down the cover, flatten the drop, and look for him with a 2-inch.

Gone! Yet stay, there is something that looks like a fringed leg on the edge of the drop; a half-inch reveals the sad truth; he has dashed through the concave boundary of his prison—smitten perhaps, Narcissus-like, with his own image—and has found an airy grave.

It would be tedious to tell of all the troubles that may yet beset the observer; let us then imagine the animal to be handsomely captured and tenderly held by the compressorium, with not more than half of his six legs twisted into some extravagant attitude. It is true that it will often even then, by means of its powerful muscles, jerk itself regularly every two or three seconds, so as to describe a circle round the points at which it is held. Nothing can be more distressing to any one watching it with a half inch or higher power in the hope of understanding its structure. No pressure short of a fatal one can prevent the motion; for Pedalion is of so broadly conical a shape that the glass can only grip two spots at once, and those on opposite sides of its body. But rotifers seem to differ in their tempers almost as much as human beings; and now and then I have lighted on a docile fellow that will lie still to be looked at. Under these circumstances, I think, few things can be seen more wonderful than the muscular system which moves this animated atom. Here are at least forty striated muscles in a creature not 1-100th of an inch in length, and those not mere repetitions of one another, as in the muscles of a caterpillar, but with every pair arranged for some special duty.

Figure 1 gives a dorsal view of Pedalion, and shows the whole of the dorsal limb (*m*) and the inner pair (*n*), with portions of the outer pair (*o*), and of the pseudopodium (*p*). Each outer limb is elevated by a pair of muscles (*b*), and depressed by another pair (*a*), each one of which bends round the junction of the limb and body, and slants downwards towards the dorsal or ventral mid line to meet there its corresponding fellow; in fact, the muscles for depressing the outer pair of arms (*o*) make together a complete circuit of the body, meeting in V-shaped fashion on the mid-dorsal and mid-ventral lines, as well as in the limbs themselves. This is also shown in fig. 2, where all the repeated muscles of fig. 1 bear the same letters.

The dorsal limb (*m*) is depressed by a pair (*h*), which run along its sides, and then making a sharp turn at right angles, enclasp the whole body, and meet on the mid-ventral surface; it is raised, I believe, by branches thrown out by the pair (*k*), as is best seen in fig. 2; but I never could quite satisfy myself of the working of these muscles.

The inner pair of limbs (n) are depressed by the muscle (d), and raised by a pair (c), which meet in V fashion at the elbow, as it were, of this arm.

From the point in the dorsal surface where these last four meet, spring four other powerful muscles in two pairs (e), which run right round from the dorsal to the ventral surface, and after following a course nearly transverse to the length of the animal (see figs. 2 and 3), enter the pseudopodium by a turn nearly at right angles, and are attached, the upper to its lower portion (fig. 2, t), and the lower to a spot (fig. 2, u), around which the pseudopodium can be bent like a hinge, and so thrust out at right angles to the body, or even drawn right up parallel to it, but pointing the wrong way.

The circular muscles (fig. 1, f, g) surround the neck and trochal disc, and serve to enable the creature to regain its right shape when it has contracted its length by means of its longitudinal muscles—viz. two dorsal ones, which are shown in fig. 1, five more side ones in fig. 2, and yet another pair of ventral ones in fig. 3. The pair (fig. 2, s) moves the ciliated chin. All these muscles are coarsely striated.

Gosse pointed out in vol. ii of the 'Popular Science Review,' 1863, that Polyarthra, as well as other rotifers (Dinocharis, for example), had true condyles in the joints; and that this was one of several weighty reasons for giving the whole class "a high place in the natural system," near the articulata rather than the annelida; and surely Pedalion's limbs, worked by such muscles and having such obvious joints, not only bear out Gosse in his assertion, but amply justify Sir J. Lubbock in stating that "some of the Rotatoria, such as the very remarkable Pedalion, seem to lead through the Nauplius form to the Crustacea."

Within the last week I have captured many females with clusters of male eggs attached to them. Female eggs are never carried more than one or two at a time; but the male eggs generally hang in bunches of a dozen or a dozen and a half. They are, too, only half the size of the female eggs, and never show any structure within them except the eyes and cilia.

I had seen the young female hatched several times, and found it to be (as is always the case in rotifers) an exact repetition on a small scale of its parent—a funny, fuzzy, little thing, all spikes and bristles. The male, however (figs. 4 and 5), is a strange caricature of its mother. When just hatched, it is but 1-550th of an inch, or about one fifth of her length, and I do not imagine that it lives long enough to

grow much bigger, as most of my specimens died within a quarter of an hour after their birth.

Its shape bears a rude resemblance to Pedalion shorn of its rudder, but it swims very differently, constantly spinning round its own length like a joint on a spit. It can jerk its side arms, and it uses them in this way to free itself from its shell; but the arm bears only a long bristle or two, not fringes like those of its mother.

It possesses also longitudinal muscles for retracting the head, and it can do this so far as to bring its two eyes down into the centre of its body. On the death of one of them I observed the (usually inverted) penis protruded to a length quite equal to that of half the animal.

Pedalion's stomach, with its two oval glands and œsophagus, is similar to those of Triarthra, and its mastax (flattened by the compressorium) is shown in fig. 6. Fig. 7 is an enlarged view of the retractile antenna shown, with its muscle (*q*), at (*r*) in fig. 2.

The two ciliated projections at the end of the animal are of the most variable length in different individuals, in some being scarcely visible; they are always very short in the newly hatched females. They are, I believe, merely another form of the secreting pincers (as they are termed) of Hydatina, Synchæta, &c., for I have seen a dying Pedalion moored by its own viscid secretion to some algæ, and slowly swimming in a wide circle by help of this natural rope, which in this case distinctly originated in an extremity of one of the ciliated projections. The use of the cilia, I imagine, is to keep the viscid extremities clear of floating atoms.

Remarks on Pedalion. By E. Ray Lankester, M.A.

The form which Dr. Hudson has made known in the preceding paper is one which cannot fail to arrest the attention of all zoologists at the present time, who are interested in speculations upon the genealogy of the animal kingdom. Dr. Hudson had the great kindness to send me living specimens of his rotifer, and I am, therefore, able to join my testimony to his, and can speak to the accuracy of his drawings and description. In addition to its ciliated discs Pedalion possesses four pairs of movable appendages—two median dorsal, two median ventral, two right lateral, and two left lateral. All these have fibres of transversely striated muscular tissue inserted at points in their walls, by which they are moved.

Proceeding from before backwards, we find below the mouth a median movable process bearing long vibratile cilia, which Dr. Hudson speaks of as the ciliated 'chin.' Corresponding to this dorsally is the appendage bearing motionless setæ at its apex, which is frequently present in rotatoria, and is spoken of as 'calcar,' 'siphon,' 'tentaculum,' or 'antenna,' sometimes being double. This appendage in Pedalion is moved by two transversely-striated muscular fibres. Immediately below the chin, in the median line ventrally, we have the great ventral limb, by far the largest of the series. It has a broad base extending almost across the whole width of the Pedalion's trunk, and is considerably longer than that portion of the animal, reaching out behind when not used for lashing the water. It tapers posteriorly, and ends in an expanded plume of eight compound hairs. Corresponding to this, on the dorsal surface, is a similar median limb, smaller in size and furnished with fewer hairs. The two pairs of lateral appendages arise from nearly the same level, or zone, as do the large ventral and smaller dorsal limbs. The more dorsally placed limbs of each of these lateral pairs correspond to one another, and, in like manner, the two more ventrally placed agree. They all terminate in a plume similar to that of the great ventral limb, which they resemble with this difference that they are very much shorter. It is impossible to deny to these appendages the title of 'limbs,' in the sense in which it is applied to the movable appendages of Crustacea. The disposition of the muscles within them, and their vigorous movements, warrant us in considering them as structures of a nature identical with that of the appendages of such a crustacean as the Nauplius-form. Yet there is no evidence in these limbs of the chitinization of the integument in segments so as to form distinct joints. It is clear that the base, or insertion, in all the appendages of Pedalion *acts* as a joint, since they are seen to bend at this part; also the large ventral limb and its smaller dorsal fellow are seen to bend at a second point, about midway between the origin and apex. The strongly marked character of the striated muscular tissue by which these appendages are worked, and the nature of the hair-like productions of the chitinous integument at their terminations, go far to justify their assimilation to a larval Crustacean's limbs, the secondary processes on the hairs being peculiarly suggestive of such affinities.

If it be admitted, then, that the appendages of Pedalion do stand in some close relationship to those of Crustacean larvæ, what are we to suppose that relationship to be? and what have

they to do with the appendages and processes seen in other Rotatoria? In the calcar or antenna of many Rotifers (double in Melicerta) we have an organ which has always suggested a comparison with an Arthropodous appendage, its representative is obvious enough in Pedalion, whilst the 'chin' placed opposite to it ventrally is known in other forms, and sometimes regarded as a part of the trochal disc, though it does not elsewhere attain the special development and the musculature seen in Pedalion. The movable spines of *Polyarthra* and *Triarthra* present us with the only approach which is made to anything like the other movable appendages of Pedalion, and they differ essentially from the latter in not being hollow processes in which the muscles run, but simply pegs worked by muscles attached to their inserted bases. The two small and two large pairs of arms in the male of *Asplanchna Sieboldii* are approximations to the development of true hollow limbs, but they are not provided with muscles. They are stated merely to shorten during the swimming of the animal. It appears that, with the exception of the calcar, there is no structure in any other Rotatoria with which any of the limbs of Pedalion can be distinctly identified. If Pedalion represents, in its limbs, a condition which was at one time common to the Rotatorial stock, the subsequent modification has, indeed, been a very profound one, for not even in the embryonic condition of any Rotifers are traces of such limbs to be detected.

On the other hand, when we attempt to compare the appendages of Pedalion, one by one, with those of a Crustacean larva, we are met by equal difficulty. You cannot, twist how you will, make out of the girdle of limbs surrounding the conical body of Pedalion, an individual correspondence with the laterally paired, ventrally placed limbs of Nauplius. The medianly placed ventral 'chin,' and great plumed limb, and dorsal antenna, and dorsal limb, seem to defy attempts at tracing any such homogeny. And yet Pedalion certainly would seem to connect the Rotatoria more closely than is at present admitted with the Arthropods. This connection may, perhaps, be conceived of in the following way. The Rotatoria, though classed by Prof. Leydig with the Crustacea, were shown twenty years ago by Prof. Huxley (whilst insisting on the identity of their cilio-vascular system with that of the Annuloida) to possess in their ciliated trochal disc an organ which could justly be compared to the ciliated bands presented by certain Echinoderm, Gephyrean, and Annelid larvæ. It seems to me to be equally true that this same organ is represented in the velum or 'Segel' of larval

mollusca. It is not an extravagant supposition that the Rotifers of to-day are the nearest representatives of the common ancestors of Mollusca, Annuloida, and Arthropoda. Supposing that the Arthropoda, or at any rate the Crustacea, were developed from such a form, we should not expect the laterally paired limbs of the Nauplius form to be *at once* evolved, limbs in various positions would obviously be possible, and after such various dispositions of limbs as might arise had had their chance (we are supposing that conditions occurred which favoured the development of such protuberances of the integument as we see in the male of Asplanchna, and the adaptation of muscular bands to these protuberances) natural selection proceeded along the definite line of paired ventrally placed appendages, which has resulted in our present Arthropods. Pedalion would then be a representative of one of the unsuccessful candidates in limb-arrangement—he remains much as that unsatisfactory ancestor of his was—whilst the forms which we must suppose did exist with trochal discs and limbs arranged more like those of Nauplius are—are non-existent to-day on account of the very fact that they lie in the direct line of ancestry; *their* descendants are the Crustacea. No doubt, by speculations similar to the foregoing Pedalion might be accounted for, as a link in a supposed retrograde evolution of the Rotatoria from Crustacea (though it is then hard to explain the water-vascular system of the Rotatoria), or other hypotheses might be framed by regarding the median unpaired dorsal and ventral limbs, as potentially lateral and duplicate, because the 'calcar' in some Rotatoria is median and azygos and, in others, is paired. As matters at present stand we really have no criterion in most cases where speculation as to genealogy has of late been applied, and can only attach the value of suggestions to such exercises of ingenuity which are, nevertheless, not to be condemned as illegitimate. It will be interesting to see how Pedalion will be dealt with by those naturalists who are constructing genealogies.

The two caudal ciliated lappets of Pedalion are very remarkable, not as indicating any affinities, but as being quite exceptional amongst Rotatoria. No other Rotifer possesses externally placed cilia in addition to those of the cephalic region.

Dr. Hudson does not mention the presence of the water-vascular system, and I may say that I failed to detect any indication of it—even when working with a No. 10 à immersion of Hartnack.[1] It is very easy to miss such a struc-

[1] In a letter Dr. Hudson states that, last year, in one specimen he de-

ture in so small an organism, but at the same time it would not be surprising were the vascular system absent in some genera and species of the class, though present in their allies. The Annelids afford a parallel.

Remarks *on the* Structure *of the* Gregarinæ, *and on the* Development *of G.* (*Monocystis*) *Sipunculi*, Köll. By E. Ray Lankester, M.A. (With Plate XX.)

The Striation of the Tunics of Gregarinida.—Whilst the term Gregarines has been in everybody's mouth in relation to a parasitic growth on hair—which could only have been ascribed to these organisms as a result of profound ignorance—there has been on the other hand considerable advance in our knowledge of the life-history and structure of those Protozoa to which the name Gregarina rightly belongs, in consequence of the admirable investigation by Professor Edouard van Beneden of the Gregarina parasite in the small intestine of the lobster.

The researches have been published in full in this Journal, and therefore in offering a few criticisms on Prof. van Beneden's most recent conclusions with respect to the structure of Gregarinæ, we may fairly suppose the reader to be acquainted already with that author's views.

In *G. gigantea* Prof. van Beneden recognises an outer cuticle, beneath this a muscular layer consisting of delicate hoops arranged horizontally at intervals in a homogeneous matrix; within this again a more or less pellucid cortical substance, and finally, the axial or medullary mobile granular "contents" with the nucleus. Van Beneden does not suggest that all these differentiations of the substance of the organism are to be found in all Gregarinida; and in this he is quite wise. I do not hesitate to state that in many Gregarinida there is nothing corresponding to his transversely striated or muscular layer, whilst in many, and in the younger condition of all, the cuticle is of so delicate a nature, if it exist at all, as not to be recognisable; *e.g. Monocystis nereidis* (*pellucida*, Köll.), and the smaller forms of *M. lumbrici*. Being greatly interested in Van Beneden's discovery of the coat of "circular fibrils" in the Gregarina of the lobster, I have taken an opportunity of examining specimens during this summer, and (using Hartnack's No.

tected two ciliated 'tags' near the head, but has not reobserved them in the present batch of Pedalion.

10 à immersion) I have quite satisfied myself of the existence of these hoop-like fibrillæ and of the perfect accuracy of Prof. van Beneden's drawings and description. But I cannot look upon these fibrillæ as muscular in the unreserved manner in which their discoverer does. To quote his own words applied by him to the protoplasmic cortical substance to which I and others have previously ascribed the motor powers of the Gregarinæ, we may say, "Nothing, however, proves the muscular nature of this coating; the transverse (longitudinal) striations are not muscular transverse (longitudinal) fibrils, but the result of a thickening, following a transverse direction, of the cortical (or we may say of the cuticular) substance." Professor van Beneden does not adduce any evidence whatever of the contractility of these circular fibrils, and it is difficult to see how he could. Whilst of their existence there is not the least doubt, I do not know of any reason for regarding them as anything but hoop-like ridges or thickenings of the cuticle, excepting this, that they do not *project* from the outer surface, but are disposed on the inner face of the cuticle. The cuticle is, as I shall show directly, subject to various markings in the Gregarinida as in Infusoria. In any case we have present in *G. gigantea* the cortical protoplasmic substance, of the contractility of which it is quite easy to satisfy oneself. Such a Gregarina as *Monocystis nereidis* (fig. 2) leaves no doubt in the mind that the cortical substance is the seat of those changes of dimensions which give rise to the animal's locomotion. The anterior region (*m*) in this species, and also in *Monocystis ascidiæ,* presents an enlargement or expansion of the cortical substance (not to be in any way confounded with the anterior chamber of the bilocular Gregarinæ), which is *eminently mobile,* changing frequently its relative length and breadth.

This expansion exhibits a permanent delicate longitudinal striation of its substance, not superficial, but deep and indicative of fibrillation. There is no trace in these forms of anything corresponding to Prof. van Beneden's muscular coat. They seem to me, together with the fact observed by me in many Gregarinæ of the concomitant decrease in motility and bulk of cortical substance, which is seen, as the Gregarinæ increase in size, and develope an abundant granular medullary substance, to warrant the view that the cortical substance of the Gregarinida is the contractile substance. Hence I should not like to pronounce the cortical substance of this particular Gregarina from the lobster to have lost its power (which, indeed, Prof. van Beneden does not altogether

do), and to have transferred it to the layer of circular fibrils, the contractility of which is altogether hypothetical. Moreover, I cannot suppose that this layer of circular fibrils exists universally in the Gregarinida. Certainly nothing so obvious as are these fibrils in the lobster's Gregarina can have escaped detection in the well-studied ***Monocystis lumbrici***, in ***M. nereidis*** (studied by me with a $\frac{1}{18}$th Powell and Lealand), nor in the ***M. sipunculi*** to be described below. It is necessary without doubt to re-examine the structure of other Gregarinæ in the light of Prof. van Beneden's observations on *G. gigantea*, and those who have the opportunity will, it is to be hoped, shortly make known the results of renewed observations.

If those who would advocate the muscular nature of Van Beneden's layer of transverse fibrils will admit that this layer is not differentiated in some species of Gregarinida, I think we obtain some argument against its muscular character; for *G. gigantea* is not a wonderfully active organism, as would be expected from such an extensively developed muscular coat. It does not exhibit movements which differ in *kind* from those of the Gregarinæ, which depend simply on the but slightly differentiated protoplasm of their cortical layer, that is to say, it does not exhibit movements which can be called *muscular* (distinguished by their definite recurrence and rapidity), in distinction from such as may be called *protoplasmic*. Though it is not possible to draw a sharp line between these two kinds of movement, nor between the two structural conditions with which they are associated, yet the very advanced condition of differentiation which the fibrils of *G. gigantea* would indicate, if regarded as muscular, justify the expectation of some marked contrast between its movements and those of such a form as ***M. nereidis***. The fact appears to be that ***M. nereidis*** is the more active of the two. It certainly exhibits far greater activity in changing its shape than *G. gigantea*, which, as far as I have observed, never exhibits a change of dimensions, but glides along in that rather mysterious manner which is also seen in *G. blattarum* and ***M. sipunculi***, and which, from what I saw in a gigantic specimen of the latter species, one eighth of an inch long, appears to be due to a slight but continuous undulation of the lateral margins of the body. The Gregarina has in this case, and in all probability generally, not a truly cylindrical, but a flattened fluke-like shape. With regard, then, to Van Beneden's muscular layer of circular fibrils, I would conclude that its muscular nature is purely hypothetical, that it is not to be looked upon as an essential part of the organisation of the

Gregarinæ, and that even if its muscular nature in this case be admitted as probable, such a view does not do away with the contractility of the typically contractile part of the Gregarina—the cortical parenchyma.

In the next place, it is necessary to make some remarks upon the striations of the tunic recognised in various Gregarinæ by various observers. In addition to his circular transverse fibrillæ, Van Beneden appears only to recognise one source of striation, namely, " a passing state of the cortical tunic," a temporary condition of contraction.

To this cause he ascribes equally the longitudinal striations observed by Lieberkuhn in large individuals of *Monocystis lumbrici*, by Leidy in the cortical substance of the posterior chamber in *Gregarina blattarum*, and subsequently by myself in the fine proboscis-bearing Monocystis occurring in *Aphrodite aculeata*, as well as " the striations on the surface of the body of a Gregarina from a Phyllodoce described by Claparède. The fibrillation which I described ('Quart. Journ. Micro. Science,' vol. vi, p. 23) in the anterior expansion of the cortical substance of *Monocystis nereidis* he does not mention (see fig. 2).

Alexander Stuart, in a paper published in volume xv, No. 5, of the 'Bulletins of the Imperial Academy of St. Petersburg,' whilst describing two new Gregarinæ respectively from the Heteropod Pterotrachea and the Annelid, Telepsavus, gives his notions upon the subject of striation. He wrongly cites my *Monocystis Aphroditæ* as similar in form and markings to Claparède's Gregarina from Phyllodoce. It is, on the contrary, very different, and he must, by an oversight, be alluding under this name to my *Monocystis serpulæ*, which is similar to Claparède's species. Stuart sets down all striations in Gregarinida to the fibrillar structure of the cortical substance, or " Muskelschlauch," as he not inappropriately terms it, and insists on the permanent character of the striations as a proof of their existence as structural elements. In the cortical substance of *M. telepsavi* he describes an outer layer of excessively fine, circularly disposed fibrillæ, and an inner series of more obvious longitudinally-disposed fibrillæ. Though he gives figures in illustration of his paper, Stuart does not give any indication whatever of the circular striations in his drawings. If they exist, they undoubtedly are evidence in favour of the contractile character of Van Beneden's circular coat.

Stuart states that the longitudinal fibrillation is the more obvious, and I may say that at the time that I observed longitudinal fibrillation in the cortical substance of *M.*

nereidis, I did not detect any evidence of circular markings. Neither Van Beneden nor Stuart recognise the existence of striations in the cuticle in any Gregarinida.

The true state of the case with regard to the striations visible in the tunic of Gregarinida appears to be this. They may occur in the cuticle (where a cuticle of sufficient distinctness exists), in the cortical substance, indicative of permanent structural elements (fibrillæ), or on the inner surface of the cortical substance, where it is passing over into the medullary substance, being in this case due to a *temporary* plication of the cortical substance.

That the cuticle should be ornamented by striations or other markings is by no means surprising, seeing that they are so usual in the cuticle of Infusoria, and in cuticular structures generally. M. Claparède's description and figure of his Gregarina from Phyllodoce leave no doubt that he refers to a fine longitudinal striation of the surface or cuticle. In describing *M. serpulæ* and *M. sabella* I spoke of the longitudinal markings of the surface as simply markings, and did not compare them in any way to the striations of the "inner membrane" or cortical substance, which at the same time were described and drawn. The longitudinal striations in these species are equi-distant, finely ruled markings in the cuticle, comparable to those in the cuticle of Infusoria. As will be seen below, the cuticle of *Monocystis sipunculi* presents markings of another class, namely, minute tubercles.

The scattered longitudinal markings of a much less definite and regular character than the foregoing, which are seen at times in the substance of all Gregarinæ, and of which I will cite as particular examples, those seen in large specimens of *M. lumbrici*, those seen by me in *M. aphroditæ* after the action of water, by Leidy in *G. blattarum*, and by Van Beneden occasionally in his *G. gigantea*, also apparently those represented in Stuart's figures, but not those described by him, are due to a plication of the cortical substance in consequence of contraction, which throws the inner surface of this dense material into ridges, rendered apparent by the less refractive power of the more fluid medullary substance in contact, or rather in continuity, with which they lie. Such temporary longitudinal ridges may be looked upon as the expression of a longitudinal *structural* arrangement in the cortical substance, but in very few cases that have been observed is there any permanent visible evidence of this structure in the form of *fibrillar* elements.

Such fibrillar elements do, however, occur in some cases, and it seems not impossible that the cortical substance of the

Gregarinida presents us with a series of gradual differentiation in various species, from a perfectly homogeneous condition to that in which both circular and longitudinal fibrils are present.

The series would be represented by, *a*. the homogeneous cortical substance of *Monocystis sipunculi* or *M. lumbrici*; *b*, that of *M. nereidis* (*pellucida*, Köll.), with longitudinal fibrillation of its anterior expansion; *c*, that of *M. telepsavi* with very fine circular and more distinct longitudinal fibrillation, though I must confess that Stuart's mode of making his statement is very inconclusive; *d*, that of *G. gigantea*, Van Ben., with its perfectly distinct hoop-like circular fibrils and subjacent homogeneous substance.

Though it *possibly* thus forms, but one of the furthest points attained in the differentiation of the primarily homogeneous cortical substance, I must refer back to what has been already said against the assumption that Van Beneden's layer of circular fibrils forms part of the muscular or corticle substance, and that it is not merely cuticular.

Monocystis sipunculi, Köll.—Among specimens of *Sipunculus nudus* which the fishermen at Naples brought me in great abundance last winter and spring I frequently, whilst working at the anatomy and histology of these worms, came across individuals infested with Gregarinæ. They usually occurred as white spherical bodies, often of considerable size (fig. *3 b*), frequently enclosed in a cyst formed by the peritoneal membrane, which everywhere lines the perivisceral cavity of Sipunculus, and is altogether very remarkable histologically. This membrane is ciliated at intervals, and those growths which invest Gregarinæ are frequently ciliated also. In fig. *3 c* a portion of one of these spherical Gregarinæ, with its nucleus and investing growth of peritoneum with ciliated patches is represented. Such cysts as these, when detached, rotate slowly in consequence of the action of the cilia, and lead, at first, to the notion that they are ciliated organisms.

On one occasion, on slitting up a large Sipunculus, and allowing its abundant pink perivisceral fluid to run into a glass dish, my attention was attracted by two white flakes of about an eighth of an inch in length, which were swimming actively in the liquid. Their movement was like that of some planarians, and seemed to depend on the undulation of their lateral margins, which were plainly seen to be in a state of vibration. These white flakes turned out to be specimens of the *Monocystis sipunculi*, differing entirely from the spherical encysted forms in shape, but, like them, having the

granular medulla and nucleus. It will be remembered that in Lumbricus, as here, two large forms of Monocystis are noticed—a longitudinal and a spherical (see this Journal, vol. vi). One of the specimens (fig. 3) had two nuclei, a condition due either to fission or to conjunction. From so large a Gregarina as this I expected to obtain some information as to minute structure, and accordingly examined the specimens with Hartnack's 10 à immersion. There proved to be a well-developed cuticle with tubercular markings (fig. 5 and fig. 4 *a*), a perfectly homogeneous cortical substance, which had a rather yellow colour, and seemed to be very dense, and then a slightly viscous medullary liquid densely crowded, as usual, with oval granules.

I am not able to give a measurement of the thickness of the cortical substance; but it was relatively of but very small development, much less in proportion to the diameter of the Gregarina than in the case of *Gregarina gigantea*. The nucleus in each case was perfectly transparent and homogeneous, and possessed a distinct membranous wall, which was left in a shrunken state on the field, when sufficient pressure was applied to burst the vesicle.

The points to which I would direct attention in this Gregarine are, the swimming movement, the tuberculate cuticle, and the homogeneous cortical substance.

Cysts from various parts of the perivisceral cavity occasionally exhibited the Gregarinæ broken up into the condition of pseudo-naviculæ. They are represented in two conditions in the plate. Like those of *Monocystis lumbrici*, which they closely resemble, the pseudo-naviculæ of *M. Sipunculi* appear at first as spherical corpuscles, subsequently enlarging, and taking on the naviculoid shape. A very coarse-grained protoplasmic mass lies within the highly refractive thick wall of the pseudo-navicula.

The pseudo-naviculæ average about $\frac{1}{2000}$th of an inch in length; they possess a shred-like filament dependent from one extremity, which is perfectly motionless.

The existence of such a process is of considerable importance, as strengthening the evidence in favour of the identity of psorosperms and pseudo-naviculæ, since the former are often provided with such long motionless processes. A much better marked case of the existence of such a rigid process came before me three years ago, in the course of some observations on *Tubifex rivulorum*. A *Monocystis* is a very frequent parasite in these worms, and is to be found in all stages, free and actively moving, conjoined in pairs (Zygocystis of Stein), encysted and divided into a greater or less

number of cleavage products; but I have only once in the examination of many hundreds of specimens of Tubifex found cysts containing fully-formed pseudo-naviculæ.

In this case there were some dozen or more cysts, most of which were crowded with pseudo-uaviculæ. These were so numerous that, when the cysts were burst by pressure, the whole of the area covered by the thin glass square, the side of which measured half an inch, was peopled with them. These pseudo-naviculæ had the form seen in fig. 19, namely, an oblong head with a stiff, sharp curved process of three or four times its length projecting from one end of it. I was unable to ascertain the further development of these bodies, but found that they possessed a marked tendency to adhere to foreign bodies which were sufficiently soft to admit of penetration by the stiff motionless filament. In this way several penetrated an uninfected Tubifex, which I placed in a small cup of water, together with a quantity taken from the specimen above mentioned.

I was not able to follow directly the development of the contained protoplasmic mass of the pseudonaviculæ of *Monocystis sipunculi*. I, however, found certain organisms on several occasions in partially broken-down cysts, and in the curious little diverticulum of the alimentary canal near its rectal portion—a site which is not unfrequently affected by encysted Gregarinæ—which I take to be the pseudo-filarial stage of the *M. sipunculi*. I have the less hesitation in considering them to be of this nature, because I frequently obtained them in great numbers from this diverticulum associated with numerous, very small, but perfectly indisputable Gregarinæ, such as is the one drawn in fig. 18. The organisms in question which often were exceedingly abundant in particular masses of tissue appearing to be old cysts, or in the before-mentioned intestinal diverticulum, measured from the $\frac{1}{1500}$th of an inch upwards in size, averaging the $\frac{1}{1000}$th. They were minute, oblong flakes of protoplasm, devoid of all nucleus or other structural differentiation, broad and rounded at one extremity, tapering and drawn out almost to a thread at the other (fig. 7). Their movements were incessant, consisting in the oscillation from side to side of the tapering extremity. The vibrations of this portion were so rapid that I at first thought that a fringe of long cilia existed on the sides of the posterior elongation of the little organism. I afterwards satisfied myself that they have the form seen in fig. 7. Whether an amœboid condition precedes this I am unable to say; but I look upon these active, wriggling cytods (for they are not yet cells) as

Braun), &c., for examples of very varied and at same time seemingly characteristic outlines.

But amongst unicellular plants belonging to the class Phycochromaceæ, so frequently found in the same situations associated with the foregoing, as well as with other less prominently marked chlorophyllaceous types, not until recently, so far as I am aware, has attention been drawn to any examples of a specially figured outline—that is, as mentioned, in shape otherwise than globular, ellipsoidal or cylindrical.

I need hardly contend, indeed, that the "figure-of-8-shape," assumed by many such during the progress of self-division, cannot be regarded as an exception, or as in itself special. Thus, in the genus Synechococcus (Näg.), for instance, the ordinary oblong subcylindrical cell becomes transversely constricted during growth, so as to assume a "figure-of-8-shape;" but the two segments having attained their full size, the constriction is simultaneously carried through and through, separation ensues, and the oblong subcylindrical figure in each new cell is resumed.

Possibly, indeed, the departure from the so frequent ellipsoidal type, which is shown by the cuneate or rather obovate cells of *Gomphosphæria aponina* (Kützing), may, so far as it goes, indicate a certain amount of approach to a special figure, enhanced, too, as it might appear to be, by the very pretty obcordate shape presented by the cells during division. Indeed, a doubly obcordate figure is not unfrequently seen; that is, when the division proceeding vertically from above downwards, being partially advanced, is quickly succeeded by a second line of division setting in at right angles to the former, also proceeding vertically from above downwards—then the shape assumed presents an obcordate outline on each of its four vertical aspects, and when viewed from above, or somewhat obliquely, is seen to be four-lobed. A cell in such a progressive stage of division is thus somewhat comparable to the figure of a four-lobed Euonymus fruit. (This allusion, of course, is only to assist in conveying a conception of the shape presented.) But, when the self-division is complete, the cuneate or obovate figure is resumed. Indeed, even the regular tapering off towards the lower or inner extremity of the cells may be possibly held to be but a consequence of their mutually approximate radial disposition, occurring, as they do, imbedded in the substance of the ends of a number of radially projected dichotomously subdivided *arms* of rather firm gelatinous matter, emanating in a somewhat stellate though quite irregular manner, from a common centre, the whole surrounded by a more or less conspicuous

gelatinous envelope, and forming an unequally rounded globose family. Gomphosphæria thus would seem to form, to a certain extent, a parallel amongst Chroococcaceæ (Phycochromaceæ) to Oocardium amongst Pallmelaceæ (Chlorophyllaceæ).

It does not appear, then, until the genus Tetrapedia was founded by Professor Reinsch,[1] for two new and singular exceedingly minute Chroococcaceous forms, that examples of specially figured cells were known in this family of Algæ. Here we have unicellular Chroococcaceous plants existing quite free and unattached, and, therefore, in no way acted upon by mutual pressure, or capable of being modified in outline by any mechanical exigency of position of growth, and at same time offering very characteristic and even complex figures. Inasmuch, therefore, as I apprehend Professor Reinsch's work must be but little known in this country, and as the specialities of his form seem not yet clear, upon which, possibly, observers with us, should they encounter them, might be able to assist in throwing light—and, further, inasmuch as I am myself acquainted with two other figured, but less complex, also very minute forms, clearly of similar nature, though not absolutely fitting into the genus, as characterised by Reinsch—for these reasons it has appeared to me that a notice thereof might find a fitting place in these pages, accompanied by a production of Reinsch's, as well as by a sketch of my own forms (Pl. XXI), and (although no further light can be shed upon them than that "there they are") become, at same time, a not wholly unwelcome contribution to English readers.

Perhaps, before endeavouring to convey an idea of my two less striking but new forms, it would be best to reproduce Reinsch's Latin description of his genus, and of his two forms falling thereunder, examples of one of which I have also once myself met with in a gathering made in County Westmeath. It is as follows:

Class, *Phycochromaceæ.*
Family, *Chroococcaceæ.*
Genus, *Tetrapedia* (Reinsch).

Cellulæ solitariæ aut rarius consociatione individuorum plurium familias ex cellulis binis, quaternis aut 16is exstitutas constituentes, in sciagraphia quadraticæ, cellula singula

[1] 'Die Algenflora des mittleren Theiles von Franken,' by Professor Paul Reinsch, Nürnberg, 1867, p. 37, t. ii, fig. ii, and t. ii, fig. iv. Also in the author's Memoir "De speciebus generibusque nonnullis novis ex Algarum et Fungorum Classe" (1867, p. 30, t. i, fig. A i; ex vol. vi, 'Act. Societ. Senckenb.').

incisuris quaternis in cellulas filias quaternas dilapsa, cellulæ filiæ post divisionem individuas singulas se præbentes, incisurarum directio in marginum lateralium directione perpendiculari aut in angulo semirectangulo versa; cellularum interanea granulosa, colore ærugino.

Tetrapedia gothica. P. Reinsch.

Cellulæ in sciagraphia quadraticæ, margines laterales in medio non profunde incisi, lobulo in medio paulo emarginati; cellulæ evolutiores quadripartitæ, incisurarum directio in marginum lateralium directione perpendicularis. (Pl. XXI, figs. 1 to 7.)

Latit. 0·006 mm. usque 0·008 mm.; familiæ ex quaternis cellulis extructæ latit. 0·013 mm.; familiæ ex cellulis 16is extructæ latit. 0·027 mm. usque 0·03 mm.

Tetrapedia Crux Michaeli. P. Reinsch.

Cellulæ in sciagraphia quadraticæ, margines laterales integerrimi utrimque leniter emarginati; cellulæ evolutiores (in statu divisionis) quadripartitæ, incisurarum directio in marginum lateralium directione angulo semirectangulo versa. (Figs. 9 to 10.)

Cellularum (in statu divisionis) latitudo 0·008 mm. usque 0·012 mm.

The first species (*T. gothica*), I have never had the good fortune to encounter, and would, indeed, be extremely glad to have an opportunity to examine so remarkable a unicellular growth. As is seen from the figure (Pl. XXI), a young cell in *T. gothica* is compressed, quadrate, slightly emarginate at the middle of each lateral margin, the angles rounded, a slight marginal concavity between each of the four central emarginations and each of the four angles (figs. 1, 2); side-view oblong, concave at the middle at each side, and broadly rounded (fig. 7). By-and-by, as would appear, the cell becomes more and more deeply incised at all the four sides, the incisions, taking origin equi-distantly from the angles—that is to say, from each of the four lateral emarginations, of which, indeed, these are but the initiations—proceed in a direction perpendicular to the sides, until they *almost* reach the centre (figs. 4, 5). The cell is now cut very nearly into four quadrate quarters, but these remain still mutually attached by a narrow connecting portion, and, of course, this forms a bond of union, and must maintain a passage of intercommunication between the cavities of the four quadrate sections; this, at least, is very plainly conveyed by Reinsch's figure. *Pari passu* with the progress of these lateral and vertical in-

cisions, a growth or increase of dimensions, so far as we can judge, seems to occur, and each of the four quadrate sections, when the incisions have progressed to this extent, appears to be about equal in size to the original single quadrate cell. The line of incision does not appear to be simply rectilineal and acute below, but it leaves a somewhat considerable interval between the segments, and at the lower or inner extremity it is bluntly rounded, and higher up it offers a somewhat undulate appearance, whilst the general or average breadth of the incision is pretty much alike throughout. This undulate outline is due to the circumstance that each of the four margins of the four segments, the two inner of each, as well as the two outer, at this stage possesses a minute emargination at the centre, the two *new* angles (or those at the top or outer extremity of the incisions) being rounded off similarly to the single *old* angle of each (or those forming the four angles of the primary quadrate cell). As in a single cell, the intervals between the central emarginations and the angles offer a slight marginal concavity; the remaining angles of each of the four segments are, of course, those by which they remain mutually connected. In fact, we have now presented a cell with four quadrate segments, mutually bonded together by the inner angles, the whole as yet forming but one common cavity, each of these four segments, except as to their being so united by one of their angles, offering all the same characteristics as the original single quadrate cell (fig. 4). A further degree of complexity seems now to arise. Taking origin from each of the emarginations at the centre of each of the sides of all the four quadrate segments, into which the original cell has become subdivided (as well from those bounded by the lines of incision as those external), a secondary incision takes place, proceeding likewise in a direction perpendicular to the sides, and progressing until each of these two almost reaches the centre. Like the incisions of the primary cell, they also are somewhat wide, rounded below, and with a somewhat undulate outline, due to precisely the same circumstance, that at the middle of all the sides of each and every of the new quadrate segments (the inner as well as outer) a minute emargination presents itself, and the angles being rounded, with a slight concavity between these and the central emargination. *Pari passu* with the formation of these further incisions of each of the now new quadrate *segments of the segments* of the original quadrate cell, they, too, in their turn become increased in size, so as to equal their predecessors, as these equalled the original cell, whilst they, likewise, remain bonded together by the

inner angles, the incisions not proceeding so far as to effect a complete separation. There is thus now a highly complex form produced: sixteen quadrate segments have resulted from the formation of the primary and secondary sets of incisions, and these are combined into one *tablet* by five points of mutual union; that is to say, the single median point of union of the group of four primary segments, the result of the first segmentation of the original quadrate cell, and the four points of union of *four sets* of four segments of the primary segments, now having each attained the original dimensions. The original quadrate cell has now become a quadrate tablet of sixteen times its superficial dimensions, composed of sixteen compartments, divided off by deep incisions, three from each side of the *tablet;* each of these proceeding from the middle of each side to the centre is, of course, cruciform, whilst the two others, reaching only to the point of union of each of the secondary sets of segments, are simple; but all the cavities of all the compartments of the tablet maintain, of course, a common intercommunication at the before-mentioned five points of junction (fig. 6). Such an example, indeed, as this calls to mind a *door-key* of many *wards*, if so homely an illustration be allowable.

Nor does this appear to be all: judging from Reinsch's figures[1] (see our figures 5 and 6, after Reinsch), and from just a single mention made in his explanation of the plate, a further apparently singular characteristic appertains to this most curiously complex form. It would appear that even at a comparatively early period of the progress of growth of this form, that is, in examples with only four primary incisions, a foramen or aperture—an indubitable *hole* (" Loch ")—exists right through and through the cell at the very centre of the common point of union of the segments, or in a sixteen-segmented tablet five such *holes* may present themselves. These foramina are square, or rather the sides of the short *tube* thus formed are somewhat convex inwardly, and thus the angles acute. In one of Reinsch's figures (fig. 5) this opening is delineated with its *angles* towards the ends of the incisions, and in another (of a sixteen-segmented tablet, fig. 6), the *sides* of the opening are shown as towards the ends of the incisions (the author does not himself refer to this difference). To judge from Reinsch's figures, these *holes* seem very remarkable; they are not holes in one side of the cell-wall, which, as we know, can sometimes occur, as in cells of Sphagnum-leaf, the openings in the oogonia of Œdogonium, &c. &c., but they are holes, bored, as it were, clean through

[1] Op. cit., t. ii, fig. 1, *k*, *m*.

both walls, the membrane from both sides lining them thus making a free passage through the thickness of the cell. They are not, if we judge Reinsch's figure aright, comparable to the openings in the "cœnobium" of a Cœlastrum, or a Pediastrum, or of Gonium, &c., which are the spaces between the component individualised cells of a stratum, but here it would appear that even the tablet, shown in fig. 6, is still only *one cell*, with sixteen compartments, *nearly*, but not quite, shut off from one another, and therefore still in mutual intercommunication. Repeatedly *vertically quadripartite* is thus the main feature of this form.

One of Reinsch's figures seems to offer a deviation from the general description here sought to be conveyed (fig. 8). Four apparently distinct cells are closely juxtaposed, the individual cells (instead of quadrate, the angles rectangular, but, as mentioned, rounded off) are here equally four-lobed, the lobes semicircular and entire. Thus, between the four lobes occur four sinuses, these acute-angled at the deepest point. In the centre, between the whole four cells, there occurs an acutely quadrangular hollow-sided vacant interval of equivalent length and breadth, and between each pair of the four-lobed cells also an acutely quadrangular hollow-sided vacant interval, longer than broad, the longer diameter of these four interspaces running in the direction of the angles of the equally quadrate central vacant interval—the form and direction of these (*five*) interspaces being, of course, simply due to the semicircular outlines of the lobes of the juxtaposed cells. One can, in fact, exactly reproduce the *outline* presented by the form in question, and even bring out the whole of the characteristics of the *contour* of fig. 8, by placing sixteen similar *coins* in four groups of four each, the coins so much overlapping one another as to allow, as nearly as possible, just one half the circumference of each to remain uncovered. Of this form Reinsch has seen but a single specimen, and, referring to it as he does only in the description of the plate, is disposed to take it for a distinct plant.

Such (with this aberrant, or more likely quite distinct form) is this interesting chroococcoid, *T. gothica* (Reinsch), so far as we are able to gather from the material afforded. The question is, what is its mature state? Do any portions, more densely filled with contents, become shut off, as resting-cells or "spores" (such as in Anabaina)? What limit is there to this subdivision? Figure 6, with its sixteen-quadrate segments, offers at all the sides of all the segments the same minute central emargination as in the earlier conditions, indicative (?) of a further formation of similar incisions,

which, if carried out to the same extent, would result in each of the sixteen segments being cut into four further (tertiary) segments—such a tablet as fig. 6 represents would then become one of sixty-four segments of four times the superficial dimensions of the former. Do the segments, at some epoch, and what, become cut through, and such as fig. 1 or 2 result? The words of Reinsch's description convey that this takes place, though he has nothing afterwards explanatory as to the point. Are the *holes* a constant characteristic? or can they point to an impending dislocation or disuniting of the segments, this initiated, in a singular manner, it is true, at a new place of origin, instead of by a carrying onwards of the vertical incisions? The foramen or *hole*, shown in fig. 5, resembles the central *interspace* of fig. 8, owing to the direction of its angles, but the holes in the compound tablet, shown in fig. 6, as before drawn attention to, have the angles in the reverse direction. They are depicted as, and denominated *holes*, by Reinsch; may they be, after all, but interspaces, and the segments distinct cells, cohering at the adjacent angles by a gelatinous *cushion* (not united by a narrow isthmus of the cell itself, this afterwards perforated), and thus the opening amounting to no more than a break in the temporarily *cementing* medium? But if, as we must infer as yet, they are truly openings formed in the "cell" itself, they do not seem to present themselves for some time, apparently at least until the primary incisions are advanced; and the question arises as to *how* they first originate?

Nor, indeed, are queries similar to those suggesting themselves, touching *T. gothica*, apparently at all more capable of receiving satisfactory replies, as regards any of the three other forms constituting with it the subject of the present communication. The second form referred to this genus by Reinsch, *Tetrapedia Crux-Michaeli*, is (like the preceding) very minute, compressed, quadrate, the lateral margins entire, and, in all the examples noticed, with two shallow sinuses or concavities extending from the middle point of each side on to the angles, thus producing an obtuse-angled central protuberance, the margin at all the four angles deeply and obliquely incised, the incisions reaching to nearly two fifths of the diagonal diameter of the cell, their sides rectilineal, acute at the inner extremity, slightly widening upwards (fig. 9). The incisions thus bisect the right angles of the quadrate cell, and subdivide it into four broadly cuneate segments, the outer angles of which are sub-acute, and with the two gentle sinuses, as before referred to, occupying the whole of the outer margin. The edge or side-view of the

cell presents a lanceolate outline, the extremities acute (fig. 10).

The quadripartite condition is regarded by Reinsch as a "state of division;" but he does not figure or refer to the simple or undivided state: it is not clear, indeed, how the carrying onwards of the incisions to completion, even until it should involve entire separation of the segments, would result in the formation of a secondary set of *quadrate* cells, like the young form—if pushed through and through the quadrate cell would simply become cut into four triangular ones—two sides straight and one with the two sinuses.

One might, suggestively, however, put the following possibility. Assuming the incisions carried on till four distinct younger cells were produced, of course of the triangular figure, they each would be equal to one fourth the superficial dimensions of the original cell, and they would *resemble* a moiety of a similar cell of one half its superficial dimensions, and *as if* separated from its assumed fellow *diagonally*. Now, we might suppose each of them capable of growing a new half of triangular form, the obtuse-angled prominence taking the place, as it were, of a kind of *punctum vegetationis*, that is (so to say) *as if* the cell were stretched or pulled by some force to double its size, the little prominence always remaining the apex, until a quadrate figure were attained; it would, of course, likewise be requisite to suppose a general increase in size of the whole cell thereupon, or *pari passu;* they occur, however, of varying sizes. It would further be necessary to suppose a new incision to originate at each angle, and the central protuberance to be developed at each side, producing the two sinuses. Were all this accomplished in each of the separated cuneate segments, four new similar cells to that figured would be the result. This, however, is but quite conjectural, and it seems to remain quite uncertain as to how the cells grow and divide into new cells. The few examples I have seen were similar to those figured, that is, deeply incised with the four broadly cuneate segments, the specimens slightly differing in dimensions, and showed no tendency to any further alteration. There is a certain amount of possibility of this form being taken for a minute Pediastrum (Meyen); but apart from the *colour* of the contents there is no Pediastrum with similar outline of the cells, and, indeed, as regards the examples hitherto seen, the common union of the segments at their bases prevents any confounding with a Pediastrum, which is composed of distinct but closely juxtaposed cells, held together as a frond or "cœnobium" by a kind of hyaline "intercellular

substance." *Obliquely quadripartite* is thus the great feature of this form.

Not less problematic, on all points, is the third form (figs. 11, 12) I would draw attention to, one which, so far as I can learn, has not hitherto met observation;[1] it is clearly, however, one of kindred nature to the foregoing. The most ready manner to convey an idea of the figure of this also very minute form is, to say it *resembles* that of an Arthrodesmus; in other words, it is compressed, quadrangular, divided by two opposite, deep, wide, triangular notches into two broad cuneate segments, their lower (or inner) sides slightly convex, and the outer angle subacute, and very minutely apiculate, and the upper (or outer) sides *very slightly* concave at the middle, somewhat raised towards the angles,[2] the contents pale æruginous colour, and homogeneous looking. This form occurs of different sizes, some of them being twice the linear measurements of others, but, as mentioned, even the largest is exceedingly minute. Though thus *arthrodesmoid* in figure, apart from the *colour* and a general aspect of contents, the greatly differing sizes occurring in one and the same gathering would prevent this being taken at all for any desmid; neither in this nor the following form is any gelatinous envelope apparent. A certain amount of a kind of movement shown by this form is, perhaps, not at all special, yet

[1] During the interval that the above paper was in the hands of the printer, I enjoyed the great gratification and valued privilege of making the personal acquaintance of Dr. Veit B. Wittrock, of the University of Upsala, on the occasion of a (too brief) visit of his to this country—an occasion of which I must ever retain a lively and pleasing recollection. We spoke, *inter alia*, of these forms, the subject arising from his having shown me a sketch of a minute form found by him in Sweden, which I at once recognised as most probably identical with that above recorded as *Tretrapedia Reinschiana*. I had fortunately, ere long, an opportunity to show Dr. Wittrock, a fresh example not only of this, but likewise of the other form now here named *Tetrapedia setigera* (we were at the moment in the far West, in the middle of Connemara's wilds), and I hope that skilled and accomplished observer may not consider it too great a liberty on my part to mention that, whilst he identified the former as occurring in his country, he likewise concurred in my view above expressed in regard to both, as to their nature and affinity.

[2] I regret that the figures in the plate (figs. 11 and 12) do not sufficiently accurately indicate the characteristic sought to be described by the words "somewhat raised towards the angles;" the figures show the upper margin of the segment too uniformly concave, whereas each lateral portion or lobe of the segment presents rather a mammillate outline, that is the upper margin (as well as the lower) slightly convex towards the angles, but concave at the middle. It will be, of course, understood that the two figures (11 and 12) each show an individual, one with the "segments" lying horizontally, the other vertically, the deep sinus being that making the bilaterality, or *arthrodesmoid* contour.

it is always somewhat strikingly evinced. I allude to a gentle jerking or oscillatory movement of each cell—a sort of quiet from-side-to-side vibration, generally, *as if* on a pivot running through the isthmus, the radius of action being but restricted, yet constant. Owing to this gentle movement not being quite equable, in fact rather irregular, a change of position of the cells occurs, but no noteworthy or decided change of place. I would not be disposed to attribute any great importance to this, yet it is a minor phenomenon, which, in this little form, when met with, hardly ever fails to arrest one's attention. This must, I should think, be accounted a rare form, though it casually turns up in several places, especially from county Dublin and county Wicklow. I have not been able to see any new growth or formation of younger segments, nor any noteworthy difference in the examples now and again offering themselves, save as before mentioned, in dimensions. *Bilaterality* is thus the speciality of this form.

Even still less offering any tangible grounds upon which to form a conjecture as to its mode of growth is the fourth form in question; one, however, seemingly undoubtedly of a similar nature, and hitherto apparently unobserved (figs. 14-17). This is also extremely minute, and is compressed, triangular, the sides each with a single deep rounded sinus; thus the cell three-lobed, the angles broadly rounded, and each tipped with an extremely slender linear bristle, in length almost equal to or slightly longer than the diameter of the cell itself. The contents are extremely pale æruginous green. Thus, the broad (or front) view might be comparable to the end view of certain Staurastra, or even, perhaps, still more aptly, it might be likened to a minute form of Polyedrium (Näg.), such as *P. trigonum*. But a second glance would suffice to place beyond the smallest doubt that we had no Staurastrum before us; and, apart from the minute size, the colour and aspect are abundantly characteristic to render it at once decisive that this can be no Polyedrium. No linear incisions have ever been seen to occur, consequently the cells do not present themselves as segmented, though forming three equally divergent lobes, separated by the deep rounded sinuses; hence no example has been met with showing any evidence of any mode of self-division. Their sizes vary, but not so much as do those of the preceding. The most singular feature is the possession of the very fine linear spine or bristle at each angle or extremity of the lobes, inasmuch as an appendage of such a nature would seem to be probably without a parallel in Chroococcaceous forms, unless, indeed, the

tuft of hair-like filaments surrounding the terminal "heterocyst" of a Cylindrosperum may be something analogous But there they are irregular and more hair-like; here solitary, definite in position, longer, and more like a very delicate linear spine; that is, not thicker at the base, or at any portion of its length. I have met with this organism on several occasions in moor-pools, chiefly in the counties of Dublin and Wicklow; it is possible it may be pretty generally diffused, though not often seen, which may, indeed, in great part be due to its great minuteness. *Triradiate* and *setigerous* are thus the special features of this form.

Having thus tried to convey a conception of these four unicellular *figured* chroococcoids, the two first mentioned of which form Reinsch's genus Tetrapedia, as established by that author (op. cit.), it remains to consider in what manner the two latter, hitherto unrecorded, could be associated therewith. Taking the terms of the genus Tetrapedia, as founded, the two new forms would not correctly fall thereunder, the characters being based necessarily on the outward figure. If, indeed, it should be rigidly held that my two forms should be decidedly excluded from Reinsch's genus, in such case, fixing the generic limits on the same principle, each of these would seem to demand to be regarded as the types of two separate new genera; for to myself each would appear to be as distinct from each other as either from the two Reinschian forms. But, nevertheless, all the four forms are, I venture to suppose, sufficiently clear to be regarded as closely kindred; they are all compressed, angular, deeply subdivided either by narrow, even linear incisions, or by broad, angular, or rounded sinuses.

The third form referred to (figs. 11, 12), with its two broadly cuneate segments, is *comparable* to *T. Crux-Michaeli*, as it were, deprived of two opposite segments; no doubt, even for a moment supposing it possible to operate on an example so as actually to remove two of its segments, the result would still not be at all *identical* with my form in the contour of the remaining segments; therefore, so far as one can fairly judge, it would not be a reasonable assumption to regard it as a binate or, so to say, depauperated *variety* of *T. Crux-Michaeli* (Reinsch). It does seem the new form alluded to is not apparently at any time, so far as it has presented itself, divided "incisuris quaternis," yet still the approximation or "affinity" cannot but be regarded as sufficiently striking. The fourth form (figs. 14—16), with its three angles only, and its slender filiform or bristle-like processes, appears, indeed, more distinguished from the rest; but apart

from having but three apices, its more projecting but comparatively less broadly rounded lobes call to mind Reinsch's (unnamed) form, fig. 8, with its four semicircular lobes, cruciately arranged, and with a shallow subacute (instead of a broadly rounded) sinus between them. As before, we might momentarily suppose it possible to deprive one of such forms as fig. 8 of *one* of its semicircular lobes, and the remainder "shoved round" so as to render the now (supposed) but three to become equidistant, still, even apart from the bristles, the forms would not be alike, yet, as in the previous case, the approximation or "affinity" cannot but be regarded as sufficiently striking; and further, my fourth form, this admitted, would seem thus (through such as fig. 8) to be connected even with *T. gothica* (Reinsch).

So far, then, as our acquaintance with these little algæ here referred to reaches, there appear to exist four (if not five) distinct yet kindred *figured* "Chroococcaceæ"—their remarkable shapes preclude their being regarded as "Lichen-gonidia," but whether mature plants or stages in the growth of any more complicated structures remains a problem. Ours are at least forms which here and there recur, and one can at once recognise them as always offering the same characteristics, and as maintaining their apparent individuality. Whether they are "species" or not, it may be a matter of convenience, should observers meet them elsewhere, and be able to throw a light upon them, to have at least a means of their recognition. For the reasons mentioned, it occurs to me as preferable (at least provisionally and temporarily) to record them under Reinsch's genus, if, indeed, that observer may not consider it unallowable so far to modify the terms thereof as to admit of its embracing the two new forms. It may be objected that the very name of the genus would preclude the admission of a *three*-lobed form into it, but the name Staurastrum is retained, though only a minority of the forms referable thereto are cruciate or quadrangular in end-view; so also, with Triceratium—where four- and five-angled forms occur, and so on. I venture, then, to cast the descriptions of these forms as follows:

Class, Phycochromaceæ.

Family, Chroococcaceæ.

Genus, Tetrapedia (Reinsch) mut. quodammodo char.

Cells compressed, quadrangular, or triangular, equilateral, becoming subdivided into quadrate or cuneate segments or rounded lobes, either by deep vertical or oblique incisions, or by wide angular or rounded sinuses.

Tetrapedia gothica (Reinsch).

Cells quadrate, angles rounded, lateral margins emarginate at the middle, whereat afterwards deeply incised; each of the four roundly angled quadrate segments thus produced becoming equal in dimensions to the original cell, and their lateral margins emarginate at the middle, whereat afterwards also deeply incised; each of the sixteen (secondary) roundly angled quadrate segments thus produced becoming equal in dimensions to the original cell, and their lateral margins emarginate at the middle (whereat afterwards incised?); all the incisions perpendicular to the sides, rounded below, somewhat wide, of an equal average width throughout; ultimately a quadrate foramen through the cell at the central points of junction of the segments (the incisions afterwards completed and the segmented tablet breaking up?); in side view the single cell oblong, at the middle slightly concave at each side, ends rounded.

Figs. 1 to 7. Diameter of single cell about $\frac{1}{4165}$ to $\frac{1}{3125}$''.

In a ditch, and in a mill-race (very scantily) near Erlangen.

(It seems to be probable that another distinct form exists, as above referred to, that figured by Reinsch,[1] and reproduced in accompanying figure (fig. 8).—Should that form recur to him, probably he may be in a position to throw further light on it on a future occasion.)

Tetrapedia Crux-Michaeli (Reinsch).

Cells quadrate, lateral margins entire, with two shallow concavities, each extending half the length of the sides, thus producing an obtuse-angled central prominence, deeply incised at the angles, incisions diagonal, rectilineal, deep, acute below, slightly expanding upwards, thus bisecting the angles and dividing the cell into four broadly cuneate segments, the upper angles of which are subacute (the incisions ultimately completed and the cell breaking up?); in side view lanceolate, ends acute.

Figs. 9, 10. Diameter of cell about $\frac{1}{3125}$ to $\frac{1}{2083}$.''

In running water (very scantily) near Erlangeu; also (very scantily) near Mullingar, Ireland.

Tetrapedia Reinschiana, nov. sp.

Cells quadrangular, two opposite margins excavated by a wide triangular sinus, thus subdividing the cell into two broadly cuneate segments, connected by a wide isthmus, and

[1] Op. cit., t. II, fig. ii, *i*.

somewhat convex on their lower margins; the other opposite margins of the cell, that is, the upper margins of the segments, very slightly concave at the middle, somewhat raised towards the sub-acute minutely apiculate outer angles;[1] in side view oblong, constricted at the middle, ends rounded.

In moor pools, Counties Dublin, Wicklow, and Galway.

Figs 11, 12, 13. Diameter of largest cell met with (from angle to angle in both directions equal) from about $\frac{1}{2500}''$ to say one third or even one half smaller.

In venturing to associate Professor Reinsch's name with this species, I may take the opportunity to express the great pleasure with which I have availed myself of his interesting papers and correspondence, though unable to concur with certain of his views; and I would also use the occasion to thank him highly for the valuable and much esteemed favour conferred by his having been so good as to forward me copies of his memoirs.

Tetrapedia setigera, nov. sp.

Cells triangular, each lateral margin somewhat deeply excavated by a broad rounded sinus, dividing the cell into three lobes rounded at the ends, and each terminated by a very delicate straight bristle, in length about equal to the diameter of the cell; in side view oblong, somewhat inflated at the middle at each side, ends rounded, and each seen tipped by the bristle.

In moor pools, Counties Dublin, Wicklow, and Galway.

Figs. 14, 15, 16, 17. Diameter of cell (without bristles) about $\frac{1}{4000}$ to $\frac{1}{3400}''$ from end to end, including the bristles about $\frac{1}{1550}$ to $\frac{1}{1100}''$.

Of the genus Tetrapedia and the two original species therein included by him, Professor Reinsch has furnished in his work only the diagnosis (previously herein repeated), and the explanation of the figures, whence we can draw information or gain a knowledge of his views. His figures are given in the original upon a very large scale indeed, and hence probably calculated to induce misconception as to the actually very minute size of the forms; the majority of them are here reproduced upon a scale of some 400 diameters, and the best "explanation of the figures" that can accompany them will be simply a direct translation, though not taken in precisely the same order, from the original:

Tetrapedia gothica (Reinsch).

Fig. 1. A simple developed cell, whose lateral margins present the indication of division.

[1] See note, *antè*.

Fig. 2. A cell with the indication of division, the angles bluntly rounded.

Fig. 3. A cell [the division] somewhat more advanced.

Fig. 4. A four-celled family, the cells still connected in the middle by the angles, the depth of the incisions almost the breadth of the cells, the individual cells almost fully formed, that is to say already with the commencement of a division into a new cell-generation, the margins of the side lobes of the cell somewhat emarginate at the middle.

Fig. 5. A four-celled family, the tablet (Scheibchen) furnished at the middle with a quadrangular *hole* (Loch).

Fig 6. A sixteen-celled family, formed from four smaller families, still connected at the corresponding angles, all the cells of like figure, and presenting the indication of continuous division [no further reference is made on the part of the author to the holes].

Fig. 7. Side view of a cell.

Fig. 8. A four-celled family of peculiar form, which, perhaps, represents a distinct species, of which, however, I [Professor Reinsch] have observed but a single specimen; the cell cruciate, formed of four semicircular lobes; but whether the cells represent the developed condition, or the condition of beginning of a new division, I [Professor Reinsch] do not venture to decide; the dimensions as in a four-celled family of the ordinary form.

Tetrapedia Crux-Michaeli (Reinsch).

Fig. 9. An individual in the state as observed, showing the division furthest advanced.

Fig. 10. Side view of the same individual.

Tetrapedia Reinschiana (Arch.).

Figs. 11, 12. Front or broad view.

Fig. 13. Side view.

Tetrapedia setigera (Arch.).

Figs. 14, 16. Front or broad view.

Fig 17. Side view.

Fig. 18. A minute Nostoc, with spores.

On a Minute Nostoc *with* Spores, *with* Brief Notice *of* recently published Observations *on* Collema, &c. By William Archer.

The appearance of a highly interesting and noteworthy communication from Professor Max Reess, conveying a description of certain novel experiments instituted by him on the growth of a Collema from the spores, and giving his views as to the bearing thereof as regards Nostoc,[1] which I have only just seen, recalls to my recollection a seemingly remarkable though isolated example of a not uncommon minute aquatic Nostoc, with *spores*, brought forward by me at a recent meeting of our Microscopical Club, but not publicly exhibited, from want of time, and since then somehow overlooked to be recorded.

The little Nostoc, presenting the speciality to which I am desirous of directing attention, is a very minute one, though the dimensions of the subglobose or elliptic fronds vary much. It is rather common in moor and certain bog pools. On account of its small size, therefore readily capable of compression, and its pellucid character, the elegant arrangement of its tortuously twisted rather large moniliform filaments, is often nicely seen, and this causes it to be a very pretty and favorable illustrative example of its type for examination in its entirety under the higher powers of the microscope. Its minute size calls to mind *Nostoc minimum* (Currey),[2] but in it the cells are described as quadrate, with a sinus at each side, lending a crenate outline to the filaments, and the heterocysts are large, whilst here the cells are orbicular, or for a time slightly flattened at the junctions, and the heterocysts are but slightly wider, though longer than the ordinary cells. This plant is probably identical with *Nostoc paludosum* (Kütz.), though, as regards anything to be deduced from the heterocysts, Kützing is silent. But the interesting point connected with it is a single example of it having presented indubitable "spores," of precisely similar nature to those in Sphærozyga, &c., but with the peculiarity of their being always placed singly between two heterocysts. The pairs of heterocysts with the intervening spore occurred at just about the same intervals as in ordinary examples

[1] Professor Max Reess, "Ueber die Enstehung der Flechte *Collema glaucescens*, Hoffm., durch Aussaat der Sporen derselben auf *Nostoc lichenoides*, Vauch." In 'Monatsb. der k. Akad. der Wiss. zu Berlin,' Oct., 1871, p. 523.

[2] Currey "On Freshwater Algæ," in 'Quart. Journ. of Micr. Sci.,' vol. vi (1st ser.), page 216.

occur the isolated heterocysts; the spores large, broadly elliptic, about one third longer than broad; their diameter more than twice the diameter of the heterocysts, about thrice the diameter of the ordinary cells; the "bright points" of the heterocysts not very conspicuous. (See Pl. XXI, fig. 18.)

I would explicitly deprecate any supposition that the observation was founded on any mere isolated filament, met with in the same material as the rest of the ordinary examples of this Nostic around, and assumed by me to have emanated from some of them, and, therefore, possibly that of some other genus. The filaments were not isolated, but, contorted about in quite the ordinary way, were still involved in the parent matrix, which was bounded by the distinct pellicle, or "periderm," generically characteristic, and in all respects, save the remarkable speciality described, this example was absolutely the same as the others in the same gathering; in fact, the little Nostoc was intact. It might be said, possibly, this little plant was rather a Monormia, but the definite periderm to the rounded fronds places a bar to the assumption, and I do not think any observer would see it and pronounce it other than a Nostoc.

In making a drawing for illustration, it is of course unnecessary to present more than one spore, with its adjacent heterocysts and a few cells of the filament. To give the total frond, and its long, tortuously looped and curved filaments, with their numerous spores and heterocysts, and to convey an idea of the matrix, with the bounding periderm, would have been an unnecessary labour and expense, and to carry it out on the scale of some 400 diameters would have occupied a very considerable space.

I would now advert to Professor Reess's views, as given in his memoir above alluded to. This observer is an adherent of the hypothesis already propounded by Professor Schwendener, as regards the nature of Lichens, who, in his turn, seems possibly to have had suggested to him the working out of some such idea as he has arrived at by the alternative conclusion put forward by Professor de Bary, as one or other being a necessary outcome or result deducible from the existent knowledge of the gelatinous Lichens (Gallertfletchen) or the Collemaceæ and allies, and seemingly embracing also Ephebe in his generalisation. This the latter thus enunciates:—"Either the Lichens in question are perfectly developed states of plants whose imperfectly developed forms have hitherto stood among the Algæ as the Nostocaceæ and Chroococcaceæ. Or the Nostocaceæ and Chroococcaceæ are typical Algæ—they assume the form of Collema, Ephebe, and

so forth, through certain parasitic Ascomycetes penetrating into them, spreading their mycelium into the continuously growing thallus, and attached to their phycochrome-containing cells."[1] The former of these hypotheses, as is well known, has many supporters, and, seemingly, a considerable amount—at least, in certain instances—of evidence in its favour. The latter hypothesis, on the other hand, has found, if fewer, even more staunch adherents, most prominent amongst whom are Schwendener and Reess.

Relinquishing the opinions supported by him in the earlier portions of his elaborate memoir on the Lichen-thallus,[2] Schwendener, before he concludes, propounds the doctrine that not only are the "Lichens" in question (the Collemaceæ, alluded to by De Bary) no "Lichens," but that the whole class, without exception, falls under the same category; that is to say, that each is to be regarded as some one or other Algal-type which has become, as it were, the home or residence of a parasitic growth—the combination of the two being, in point of fact, the so-called Lichen. His views on the question the author has given more at large, in relation to various types, in a subsequent memoir.[3] These he states generally thus:—"As the result of my researches all these growths [Lichens] are not simple plants, not individuals in the ordinary sense of the word; they are rather colonies, which consist of hundreds and thousands of individuals, of which, however, one alone plays the master, while the rest, in perpetual captivity, prepare the nutriment for themselves and their master. This master is a fungus of the class of Ascomycetes, a parasite which is accustomed to live upon others' work; its slaves are green algæ, which it has sought out, or indeed caught hold of, and compelled into its service. It surrounds them, as a spider its prey, with a fibrous net of narrow meshes, which is gradually converted into an impenetrable covering; but, whilst the spider sucks its prey and leaves it lying dead, the fungus incites the algæ found in its net to more rapid activity—nay, to more vigorous increase. . . . If this mode of illustration be permissible, this fungus forms a remarkable contrast, not only to the predatory and murderous spider, but, in quite an analogous way, to the vine and potato-fungus, as well as all other fungi which vegetate in living organisms, and destroy their host-plant, or

[1] Professor A. de Bary, "Morphologie u. phys d. Bilze, Flechten und Myxomyceten," in Hofmeister's 'Handbuch der Phys. Bot.,' Bd. ii, p. 291.

[2] Dr. S. Schwendener, "Untersuchungen ueber den Flechten-thallus," in Prof. Nägeli's 'Beiträge zur Wissensch. Botanik,' Hft. 4, p. 195 (1868).

[3] Dr. S. Schwendener, 'Die Algentypen der Flechtengonidien,' Basel, 1869.

host-animal, in the unequal struggle.[1] Such, "popularly" expressed, is Schwendener's view as to "Lichens" at large, which he now holds and supports. This quotation, I would venture to suggest, would seem sufficiently to convey its own refutation of the hypothesis, inasmuch as this assumed *parasitic fungus* does *not destroy* or live upon its assumed *algal-host*. If the "parasite" cannot be a "fungus" it must be something else—that *something else* no more nor less than the veritable "lichen," though it may be, indeed, but in part represented; though, of course, on all hands it is agreed that Lichens and Fungi, save the gonidia, have between them no absolute line of demarcation.

Seemingly, at first, more impressed with the applicability of Schwendener's hypothesis to the Collemaceæ, though he no doubt afterwards accepts its complete tenability as regards the whole class of the "Lichens," Reess conceived the idea of "sowing" the spores of Collema upon the substance of Nostoc, and a description of the experiment and its results forms the subject of his memoir previously alluded to.[2] He states, indeed, that the spores of Collema can be readily enough made to germinate upon any moist substratum, such as a glass plate, stones, and so on, and will slowly produce even a branched and sparingly jointed growth, but this goes on only so long as the reserve-stuff is supplied by the spore, but when this is exhausted the hypha-mass thus produced, though it may survive even weeks, will then slowly die off. But when he brings a spore or the young hypha upon the Nostoc, it at once becomes further developed, sending more or less copiously through its surfaces many branches, and penetrating within. Soon, however, they cease to increase in length, become swollen at the points and at other places, and become attached by these swellings upon the Nostoc. Thereupon thinner processes become sent further into the gelatinous mass of the Nostoc, from the swellings; these become branched, and, tortuously surrounding the chains of gonidia, form, in fact, the "Collema-mycelium," and the complete transformation or conversion of the "Nostoc" into the Collema is brought about by the hypha producing a peripheral stratum of fibres, from which break forth, through the "Nostoc-jelly," the first root-hairs. Such an *artificially* produced "Collema" the author had not been able to rear up as far as the production of fructification (apothecia), but

[1] Schwendener, 'Die Algentypen,' &c., p. 3.
[2] Prof. Reess, 'Ueber die Entstehung der Flechte *Collema glaucescens*, Hoffm., durch Aussaat der Sporen derselben auf *Nostoc lichenoides*, Vauch.' in "Monatsb. der k. Akad. der Wissensch. zu Berlin," Oct., 1871, p. 523.

he doubts not the tenability of the assumption that every Collema in free nature is a "*Nostoc*," thus made the nidus for the development of the spores, evolved, of course, from a preceding "Nostoc" so naturally inoculated (as one might say), that is to say, in other words, a preceding compound organization which is known as "Collema." Such is, as briefly as possible, the result of Reess's experiences, and the views he holds; it would lead too far to endeavour to go more closely into the arguments and statements of Reess and Schwendener—those of the latter applied to the Lichens at large, not the Collemaceæ only—but it may not be wholly without use to have directed attention to their remarkable memoirs.

Basing his opinion, as it would seem, at least mainly, upon the result of the experiments of Professor Reess alluded to, Professor Cohn[1] would exclude the Collemaceæ from the Lichens, which (without these), as a class, he would retain, remarking that "he knows no Algæ which could be transformed by the influence of a fungus into Usnea, Cladonia, Cetraria, &c., but that it appears to him that the parasitism has been rendered by De Bary and Reess extremely probable for the 'Collemaceæ.'"

Schwendener himself, in his later memoir,[2] figures certain Nostoc specimens whose gelatinous matrix is seen to be penetrated by what he denominates fungal threads (Pilsfaser), and these he points to as evidence of the truth of his view; that is, that they become the hypha, and that the phenomena of growth thereby induced absolutely *convert* the "Nostoc" into "Collema;" and he firmly holds his figures *prove* the case. Now, Reess, referring to these very figures, conceives the fungal threads depicted must be strictly those of a (destructive) fungus—a mould, in point of fact; he thinks, indeed, they may be anything whatever, but one thing clearly he avers, be they what they may, they are by no means a Collema-hypha, founding his opinion, of course, upon the knowledge gained from his recently conducted experiments. So that whatever may be the opinion of other observers as to the result of the researches of Reess, at least the examples adduced by Schwendener relating to Collema, it would appear, must be held as inconclusive.

It may, perhaps, be not inopportune to observe that, as must be well known, the gelatinous masses of those Algæ which grow on wet rocks and such situations, be they

[1] Prof. Dr. F. Cohn, "Conspectus Familiarum cryptogamarum secundum methodum naturalem dispositarum," in 'Hedwigia,' No. 2, 1872, p. 17.

[2] 'Die Algentypen,' &c., pp. 28, 99, t. ii, ff. 13—15.

Palmellaceous or Chroococcaceous, are prone to be more or less permeated by "myceloid" threads, and even some such as would fairly well accord with those Reess depicts for Collema, though not so copiously branched, may not be unusual. Some of these threads are, at least occasionally, those of indubitable (devasting) fungi, which, when they "attack" certain cells, destroy them; other threads, doubtless quite distinct, can apparently live independently and innocuously, though probably drawing nutriment from the common mucous matrix. What a *monstrous* and *abnormal* "Lichen-thallus" thus not unfrequently comes to view—a variable "hypha" interruptedly running hither and thither, and accompanied by "gonidia" of very heterogeneous character! The plant named by Kützing *Trichodictyon rupestre*, which can hardly be doubted to be the same as *Cylindrocystis crassa*, De Bary, is frequently (though not always) accompanied by a number of fine filaments (which seem, however, to be inarticulate), twisted in and out through the gelatinous mass made by the alga, but so running as to leave rounded spaces between, containing the groups of the Cylindrocystis-cells; they seem, in fact, to urge their way between the more dense mucous envelopes formed round the groups of dividing cells, simply because they find the intervals, being softer, more readily permeable. These filaments, whatever their nature really may be, cannot be doubted, I should think, to be foreign, though they were introduced into the generic characters by Kützing, being considered by him as somehow a portion of the structure of the alga, which, indeed, itself reproduces by conjugation, and is, no doubt, in fact, a desmid.

Schwendener claims as the foundation or basis for the production of "Collemaceæ" only such nostochaceous plants as live in moist or wet habitats—the entirely aquatic forms (Trichormus, Sphærozyga, Cylindrospermum, Dolichospermum), he considers, being inaccessible under water, are protected from the attack of the parasite, and thus "cannot enter into the 'gonidia question.'" The fact that these latter form independent "spore-cells" (reproducing the plant), he would seem, so far as we can judge, to hold as having no material, if any, bearing on the question, for he dwells only on their being submerged as giving them an immunity. "But in any case," he says, afterwards, further on, as regards the question, "whether certain species of Cylindrospermum pass into the 'gonidia state' [that is, become the basis of Collemaceæ] remains for so long doubtful, till the transition, here alone decisive, be observed. In the Collema-thallus

itself a decision is, of course, no longer possible, since the spores characteristic of Cylindrospermum apparently just as little come to development in the gonidial state, as do the 'manubria' of the Rivularieæ." (This last allusion has a bearing on Lichina, &c., which the author thinks have plants appertaining to Rivularieæ for their basis, but without *manubria*.) I would venture to suggest, were such Algæ as these truly seized upon by this completely innocuous parasite—which, if the hypothesis be true, rather tends to favour the growth and vigour of the "gonidia"—we should hardly expect that, on the other hand, the innate or inherited tendency to produce "spores" would at the same time become wholly extinguished. It would, I should venture to suppose, seem probable, even admitting the views of Schwendener and Reess as regards Nostoc, that Cylindrospermum is not likely to have anything to say to the "gonidia question." But the isolated observation, for the first time herein recorded, would seem to show that Nostoc, too, may form spores, though it be, indeed, so very exceptionally, and so extremely rarely.

The main object, then, of the present communication is to offer the following three suggestions which occur to me:—

1. To suggest the possibility that, if we may conceive Dolichospermum, &c., excluded from the "gonidia question" as forming special fruit (that is, "spores"), so might we regard Nostoc as excluded, though its formation of spores be so extremely rare. Seemingly, indeed, the capacity of forming spores by an algal species, supposed to become occasionally *lichenized*, is not a reason *against* the hypothesis as viewed by Schwendener—he only assumes that such an example of the alga surrenders, or leaves in abeyance, its tendency to the production of spores.

2. To suggest that there are veritable lichens which live submerged, and produce their apothecia. I presume, however, it might be replied that such may have received their inoculation by the parasite during some season of drought, when the *alga* lay "high and dry."

3. To suggest the possibility that the spores of Collema, if "sown" on some other gelatinous substratum, besides that of Nostoc—say, for instance, a Palmella or Mesotænium—might equally well germinate, penetrate therein, and develop a hypha.

There seems, I venture to think, no *à priori* reason against this latter supposition—inside the Nostoc, the "reserve-stuff" of the spore being exhausted, and the chains of Nostoc filaments admittedly intact, and no "root-hairs" as yet formed, the only next *immediate* source of nutriment for

the growing hypha would, I imagine, in the experiment of Reess, appear to have been the "Nostoc-jelly." Now, a "Palmella-jelly," or a "Mesotænium-jelly" (both aërial, that is, not under water), would seem in themselves to be possibly just as likely to afford the requisite *pabulum* for the germinating and growing Collema-spore. If this conjecture should be borne out, which I would indeed put with all diffidence, what would be the result of Reess's experiments, or rather, what proven thereby? Such a combination (*if* capable) with a Palmella or a Mesotænium would not be "Collema," because it would not have "nostachaceous" gonidian, or the characteristic periderm. If, indeed, we might for a moment assume that which direct experiment alone could prove, and a germination of spores and penetration of the hypha of a Collema with a Mesotænium effected, such a "lichen-thallus" would be, I apprehend, unprecedented—a hypha *like* other lichen-hyphæ, no doubt (but *known* to be that of a Collema), with large elliptical or cylindrical "gonidia" containing a central "chlorophyll-plate," and which would probably (in free nature at least, even though accompanied by the hypha), go on and produce *zygospores!*

I trust that the reader of these, and my foregoing remarks, will understand that I put them forward but with great diffidence; it was the occurrence of my little spore-bearing Nostoc which suggested to me to venture to do so. Isolated, indeed, as was that example, still, no matter from what aspect viewed, even though it be urged that we should look upon it as "abnormal" on account of its rarity, it cannot, I apprehend, but be regarded under any circumstances as to a certain extent suggestive and as possessing at least some amount of significance.

On Methods *for* Preparing *the* Organ *of* Corti *for* Microscopical Investigation. By Henry N. Moseley, M.A.

In the January number (1872) of the 'Quarterly Journal of Microscopical Science,' Dr. Rutherford makes the somewhat startling statement that the whole of histology can be gone over with a class of students in twenty-four lessons; and certainly his list of tissues to be examined in the course is tolerably comprehensive. A method for observing the structure of the retina is given; but the Schneiderian membrane,

the organ of taste, and Corti's organ, are omitted entirely. Surely this latter, at least, is of as great importance and interest as the retina. It is generally, I imagine, considered very difficult to demonstrate; and such is, as far as regards the finer relations and structure of its several components, undoubtedly the case, and in these particulars it is one of the most difficult of histological problems; but a great deal can be seen with comparative ease, and, as I have had considerable experience in the matter, I propose here to give some notes on the subject. I do not consider them to be by any means exhaustive or novel; but I have always found microscopists very anxious to see preparations of Corti's organ, and very commonly unacquainted with the methods by which they may be obtained, and anxious to be informed concerning them.

As in most histological investigations, the methods to be adopted fall under two heads. Firstly, those by which preparations may be obtained, which demonstrate the general and coarser relations of the several parts of the whole organ; that is, sections through the entire cochlea with all the parts *in sitû*. Secondly, those in which the finer structural and more intimate connection of these several parts may be observed, which more delicate points are, unfortunately, not to be made out from the former class of preparations, because the reagents which we are obliged to employ in their production alter and in a great measure destroy the finer tissues.

The more delicate structure must be studied in small portions of the organ, immersed in the fresh state in neutral fluids, or treated with such reagents as iodized serum or osmic acid.

The most convenient cochlea for the making of the first class of preparations is that of the guinea-pig, though the methods here to be described are applicable to any cochleæ; and I have thus made sections from the hedgehog, cat, dog, rabbit, rat, and human subject. A guinea-pig should be killed, and, whilst it is still warm, the head severed from the body, the lower jaw should be disarticulated, and the two tympanic bullæ exposed. On one of the bullæ being opened the cochlea will be seen projecting into the cavity, looking like a small conical spiral shell. It is free, and not more or less imbedded in the petrous bone, as is the case in most mammalia, and it is this peculiarity which renders the guinea-pig so convenient for the study of Corti's organ. The cochlea should be removed entire, the membranes closing the openings to the scalæ broken away, and the organ should be placed in a considerable volume of half per cent. solution of chromic

acid, where it should be allowed to remain for about a fortnight, the acid being changed every three days. By this time the bony tissue will have become quite softened. My friend Mr. C. Tomes suggested to me some time ago that this softening property of chromic acid was probably due to the sulphuric acid which, being used in the preparation of chromic acid, is ordinarily present in it as an impurity. Be this as it may, it is much better not to use any other acid, such as hydrochloric, to soften bone for histological purposes generally, but to trust to chromic acid solutions alone, and this is especially the case with Corti's organ.

The softened cochlea, on being taken from the chromic acid solution, should be placed for a few hours in ordinary and then in absolute alcohol. To prepare sections transverse to the long axis of the spire, it may then be imbedded in the usual manner in a mixture of sweet oil and wax, which I consider far preferable to paraffin. Sections can be easily made with a sharp razor[1] wetted with *absolute* alcohol, floated off the blade on to a slide stained with a simple watery solution of carminate of ammonium washed with absolute alcohol treated with oil of cloves, and mounted in Dammar varnish or Canada balsam, used, of course, cold.

Sections such as these are very instructive, as, owing to the spiral structure of the cochlea, the lamina spiralis and its appendages are exposed, cut through at various depths in different parts of the same section. Thus in one part may be studied the denuded membrana basilaris, ligamentum spirale, and the bottom of the sulcus spiralis a little further on, whilst the rods of Corti remain *in situ* with a section showing the structure of the limbus; further on still may be seen the superior toothed edge of the limbus and the large heap of rounded cells which lie external to those of Corti and Deiters, and form a prominent ridge on the floor of the scala media of the guinea-pig.

But in order to thoroughly grasp the anatomy of the cochlea it is necessary to have vertical sections through the central axis of the modiolus. If special precautions be not taken all the membranes, with their attached cells,

[1] The best razors for fine histological work are, as I have stated before in this Journal, the flexible edged razors made by John Heifor, and stamped "Made for the Army." The hollow ground-out surface of the blade holds plenty of alcohol, which forms a film between the steel and the section, and thus allows the latter to slip along the blade without sticking. Flat razors are an abomination for such work, though of course, necessary for section instruments. Absolute alcohol should be used for wetting the razor; it does so much more perfectly than weaker spirit, and produces good sections with less trouble.

&c., will break away on an attempt being made to cut the cochlea longitudinally, and sections will be obtained, in which nothing can be seen but the limbus and an attached fragment or two of the broken membrana basilaris adhering on the one side to the base of the limbus, on the other to the ligamentum spirale. To make satisfactory preparations, the turns of the cochlea must be filled with imbedding substance, to act as a support to the delicate structures during the cutting operation, and this must be removed from the section before it is finished. A substance is thus required which shall be both firm and also be readily dissolved away after it has done its part. The best for the purpose is a mixture of equal parts of wax and cocoa butter. The most effectual method for filling perfectly all the turns of the cochlea is to place the organ in a small porcelain dish full of the melted embedding substance, and to place the dish under the receiver of an air pump, and exhaust till bubbles cease to come from the floating cochlea and it sinks. The dish may then be taken out, and there will be time before the contents set to arrange the cochlea in a suitable position. The mass, when cool, may be removed from the dish by warming slightly the bottom of the latter, and may be cut into a convenient shape for holding in the hand.

Vertical sections of the entire cochlea may now be cut with the razor, and should be floated at once off the razor on to glass slips by means of alcohol dabbed on to the razor with a brush behind them. Serviceable sections will not, of course, bear handling with needles or lifting. The hollow turns of the cochlea exposed in the sections are filled with the imbedding substance. To remove this the sections must be treated on the slide with turpentine or benzoine, best slightly warmed. As soon as the matter is all dissolved away, which fact can be ascertained by placing the slides under a low power, the sections should be treated again with absolute alcohol to remove the turpentine. A drop of simple aqueous solution of carminate of ammonium should be put to each section, which will be sufficiently stained in from five to ten minutes. The sections should then be washed with a drop of water, all moisture removed from the slide by tipping it and wiping with a cloth, and then absolute alcohol should be again applied. When all water has thus been removed from the section a drop of oil of cloves should be put to it; and as soon as it is thoroughly transparent a drop of Dammar varnish may be substituted for the oil of cloves, and a thin glass cover put on. Some sections may also be mounted without carmine staining, the chromic acid staining being

often sufficient. Everything depends on treating the section finally long enough with absolute alcohol before applying the oil of cloves.

If all the water be not removed from the section the oil of cloves will not penetrate it, and the section will not become properly transparent.

Sections prepared in this way should show *in sitû* the ganglion spirale, the limbus, membrana basilaris and ligamentum spirale, with the bridge of Corti's rods and its accompanying mass of cells, and, at least in some of the turns, the membrane of Reissner and that of Corti. A cochlea, when once prepared in chromic acid, and transferred to absolute alcohol, may be preserved in this latter for any length of time, and will be always ready for further preparation.

For the demonstration of the lamina reticularis and the finer structure of Corti's rods, the membrana basilaris, &c., osmic acid preparations are the best. To prepare these all that is necessary is to break open the cochlea with fine bone forceps or strong scissors, so as to expose without injury as much of the organ of corti as possible, and place the pieces in a 1 per cent. solution of osmic acid. In from twelve to twenty-four hours the organ will be found sufficiently hardened, the nerve-tissue being turned quite black by reduction of the acid. Small portions of Corti's organ may be removed with a fine scalpel or scissors, and examined in glycerine, or mounted in glycerine jelly. If the cochlea made use of has been properly fresh, the lamina reticularis and rods of Corti will be found to be defined in the most striking manner.

It is hoped that these notes may be of some use to demonstrators of anatomy, &c. It is a pity that preparations of Corti's organ are not more often shown to classes. A great deal has yet to be done in the way of the comparative anatomy of Corti's organ amongst Mammalia, notwithstanding the splendid work of Boettcher. The Corti's organ of Marsupials and Monotremes would probably yield interesting results, as also perhaps those of Cetacea, seals, and otters, when compared together. Those who wish to go more deeply into the subject should consult for method Boettcher, and also Waldeyer, in the last number of 'Stricker's Handbuch.' I have unfortunately not the books at hand just now, or I would give extracts. Both authors advocate the use of chloride of palladium. Further, two papers have just appeared on the subject of Corti's organ in 'Max Schultze's Archiv,' one by Gottstein, the other by Nuel, 2nd part, 1872.

A FEW NOTES *on* MICROSCOPIC PREPARATIONS *of* INSECTS' EYES. By HENRY N. MOSELEY, M.A.

GOOD preparations which shall demonstrate clearly the structure of insects' eyes are very much wanted in this country, and, so far as I know, almost impossible to obtain; yet such are comparatively easy to prepare, and when well made from objects not only admirable for class demonstration, but also extremely beautiful in themselves.

The eye of a large sphinx moth is most easily prepared, best of all that of *Acherontia atropos*, but *Sphinx ligustri* will do well. The moth should be killed, and the head placed immediately in absolute alcohol. After it has been in the alcohol about a week it should be taken out imbedded in a mixture of oil and wax, which should be made rather hard in order to offer plenty of resistance to displacement when the chitinous parts are cut through. Sections may now be made with ease in the same way as described for Corti's organ, and the cut should be made from the convex cornea towards the ganglion. The sections should be floated on to slides, stained there with carmine, treated with absolute alcohol, oil of cloves, and mounted in Dammar varnish or Canada balsam, just as described for Corti's organ. The great thing is to use plenty of absolute alcohol, and a thin-edged hollowed-out razor. Sections thus prepared should show all the structures *in sitú,* just as given in Leydig's 'Tafeln zur Vergleichenden Anatomie,' Tübingen, 1864. Such preparations as these display the general anatomical relations of the several parts and their coarser structure admirably. The finer structure of the nerve-fibres, crystalline bodies, &c., described by Max Schultze, must be examined in small portions of the organ, macerated in iodine serum or hardened with osmic acid. Preparations of the eye of Dytiscus and other insects may be obtained in the same manner as those of large moths, but the hardness of the chitinous cornea renders the cutting of sections very difficult, and I know of no reagent which will soften the chitin without destroying the internal nervous structures. If the heads of smaller moths be used, sections, very instructive, may be prepared passing right through both eyes and the cephalic ganglia. Preparations of the eyes of mollusca, leeches, &c., may be prepared in the same way as those of insects from specimens hardened in the same manner in absolute alcohol.

METHODS *of preparing the* COCHLEA *for* MICROSCOPICAL INVESTIGATION. By URBAN PRITCHARD, M.D., Demonstrator of Physiology, King's College, London.

WHEN I undertook the investigation of the cochlea, at the suggestion of Professor Rutherford, I was totally unacquainted with the method of preserving, softening, and cutting its structures, and were I to enumerate the experiments I made, the valuable cochleæ I spoilt, and the failures I experienced before obtaining any results, I should fill many pages, and only succeed in wearying the reader by the monotomy of my disappointments. I shall therefore confine myself to describing the methods which at last proved successful, merely alluding to the chief points of the fruitless attempts.

First, then, the lamina spiralis of the cochlea may be examined in its fresh state, either as it is or stained by means of carmine, aniline blue, &c. For this purpose I found that the cochleæ of new-born animals, as kittens, the most readily worked, for in them ossification has not proceeded far, and yet the organ is nearly, if not quite, as large as in the adult animals.

But the specimens thus obtained are not of much value for showing the rods or any of the parts *in sitû;* however, I have one or two pretty preparations of the nerve-cells of the ganglion of the lamina spiralis, and also of the membrana basilaris.

Of course no vertical sections can be obtained from the tissue in a perfectly fresh state, and as these are far more instructive than the flat preparations of the lamina some method of preparation becomes necessary.

The processes consist in hardening the membranes, softening the bone, cutting, staining, and mounting the sections.

Hardening the soft structures.—For this purpose a solution of chromic acid from a half to a quarter per cent. I have found most successful, and the tissue may be allowed to soak in this fluid for two or three months, or even more; but I have obtained better results by only allowing it to remain in the solution for two or three weeks. However, I think that both the longer and shorter periods have their distinct advantages, as I fancy that some of the cells are all the better for the longer maceration. I have also obtained very good results from using Müller's fluid for hardening the membranes, &c.

Perosmic acid did not appear to me to be of any service,

but that may be because I did not use it properly; however, I should not recommend it.

Softening the bone.—This was one of my greatest difficulties, and I spoilt many valuable cochleæ before I arrived at the right strength of acid to use. Nitric or hydrochloric acid may be used; I prefer the former, and have found half to one per cent. the best strength. But the exact strength and time required must, of course, depend on the cochlea taken. Thus, a kitten's cochlea will soften in less than twenty-four hours in a half per cent., a cat's or dog's in three or four days, while the human cochlea well cut down requires nearly three weeks in a one per cent. solution. In softening the thicker and harder bones it is very important to use a large quantity of the solution, or to change it frequently, otherwise it may take months to soften.

The bone may be softened by the chromic acid alone if there be not much earthy matter to dissolve.

The softening acid should be added to the chromic acid solution during the latter days or weeks of the maceration, as the hardness of the bone requires.

Cutting the sections.—By the preceding processes the bony tissue is rendered quite soft, and the membranous tissue sufficiently hard. But on attempting to make sections another difficulty arises—the whole tissue gives way before the knife or razor, making it almost impossible to obtain a satisfactory slice, and, moreover, the membranes being unsupported, they are inevitably torn and destroyed.

Dr. Hensen recommends Böttcher's plan of injecting the cochlea with a hot solution of gelatine, which on cooling gives a very good support to the membranes. To this method, however, there are two very serious objections. First, it renders the whole cochlea still softer, and secondly, the jelly is apt to contract and drag the membranes asunder. For these reasons I was unable to make any satisfactory sections either by hand or by means of Stirling's machine.

At last I tried the following plan, which proved successful, both for supporting the membranes and rendering the tissue sufficiently tough for making thin sections. I can fully recommend it to any one who may be carrying on similar researches on the cochlea, not only on account of the satisfactory results obtained, but also on account of its simplicity and the facility with which it may be worked.

Place the softened cochlea (taken directly from the acid solution) in a small conical bag of paper filled with a strong solution of gum arabic; allow it to soak for an hour or two, then put the bag into absolute alcohol, and set aside for

twenty-four to twenty-eight hours. By that time the alcohol will have extracted the water from the mucilage, leaving behind the gum in the form of a tough mass.

This method is recommended for other tissues by Stricker.

It is not necessary to use absolute alcohol; methylated spirit of the commercial strength answers as well, if not better; and should the cochlea, on picking away the surrounding gum, be found not sufficiently hard, it may be placed in absolute alcohol for a few minutes.

The cochlea thus prepared may be cut by means of Stirling's machine and a sharp razor, care being taken to float the sections in rectified spirit, in order that the supporting gum may not be dissolved.

I found the following composition, which is recommended by Dr. Ferrier, very useful for holding the tissue in the machine:

Lard 1 part.
Spermaceti 2 parts.
Paraffin 5 parts.

Melt over a water bath.

Before leaving the subject of cutting the sections I must call attention to a very important point, namely, that of the sharpness of the razor. It is simply impossible to get satisfactory sections without a very sharp razor; to keep it sharp it should be stropped after making every dozen sections, and great care must be taken that the edge is not injured by cutting against anything hard, or else it will have to be reground. I found, with a little practice and care, that I could manage to keep a good razor sharper than is usually sent out from the cutler's as ground and set.

Staining the sections.—Of course many sections should be put up unstained; but it is better to have some stained, and if they are to be mounted in Canada balsam or gum dammar some such process becomes necessary.

I have succeeded in obtaining very good results with two staining agents, viz. carmine and gold.

1st. Carmine staining. For this purpose Beale's carmine fluid, diluted eight times with water, is by far the best to use; the sections should only be allowed to remain in it from six to twelve hours, or twenty-four if all the tissues are to be highly coloured, and then they should be removed and washed in water.

I may mention, by the way, that this plan answers uncommonly well for staining all tissues which have been hardened in chromic acid.

2nd. Gold staining. For this purpose I have found a modification of Bastian's process the most advantageous.

Place the sections in a one fifth per cent. solution of chloride of gold, allow them to remain in this about half an hour, then remove and wash. Lastly, place them in a solution containing one part of ordinary formic acid and one part of methylated spirits, and in twelve hours or more the gold will be reduced, the sections becoming purple or violet.

To hasten the process the temperature should be raised a little over 100° Fahr., and then the reduction may take place in two or three hours.

Mounting the sections.—They may be either mounted in fluids, as glycerine, a solution of acetate of potash, &c., or in resins, as Canada balsam and gum dammar.

For general purposes the fluids are decidedly preferable, because the resins make the tissues too transparent; however, if the sections be highly stained and mounted in dammar, they show very nicely the various parts of the central canal of the cochlea and the membrane of Reissner *in sitû*, especially under a low power.

Of the fluids, I prefer a solution of acetate of potash prepared as follows:

Acetate of potash 2 oz.
Spirits of camphor 30 drops.
Hot water 1 oz.

Rub down the acetate of potash in a mortar, dissolve in the water, add the spirit of camphor when cold, and filter carefully. Thus prepared, the solution should be quite clear and rather syrupy.

This has the advantage over glycerine in not rendering the tissue so transparent, in being more easily cleaned up, and in not oozing through the mounting varnish so readily.

Before mounting it is necessary to soften the gum of the section in water; this has to be done very carefully lest the swelling up of the gum or its being washed away should displace the structure too much. I say too much, because it is rarely possible to avoid some displacement, and, moreover, in moderation it is frequently advantageous. In those cases in which staining agents have been employed the gum is usually all washed away.

I have generally found it better to make a cell on the glass by means of some varnish, and then mount as follows:

Place the section in the middle of the cell with the modiolus across the slide, not in its long axis, remove the excess of moisture, then add a drop of the camphorated solution of acetate of potash, put on a covering glass with forceps,

And here I may mention that *extra* thin covering glass should always be employed, or else it is impossible to use a very high power. Run the covering glass round with glycerine jelly, when cold with a solution of gum dammar, and, lastly, when that is hard, again with Bell's cement.

I think it is as well to use layers of different varnishes; the fluid is then less likely to ooze out; of course, in putting on the jelly and varnishes, each layer should be made to thoroughly overlap the preceding one. By these means the preparations may be sealed up with great safety.

When mounting in dammar the gum should not be removed, and to prevent this spirits should be mixed with the water which is used to dilute Beale's carmine fluid. The sections are to be mounted in the ordinary way by macerating them for a few minutes in absolute alcohol, transferring to slide, evaporating alcohol, adding turpentine, removing excess when the tissue is clear, and finally adding the solution of dammar and placing covering glass on the top.

Before concluding, I must mention one of the most important points in the whole proceeding; it is the necessity of obtaining the cochlea in a perfectly fresh state. In the smaller animals, when the brain is removed, any time within twenty-four hours will do very well, but when we come to the larger animals, and especially man, it is necessary to remove the cochlea within ten or twelve hours after death, otherwise the brain, which decomposes so rapidly and lies close to the delicate structures required, hastens decomposition, destroying all traces of the organ of Corti.

This has been my great difficulty with the human cochlea, and I have not yet succeeded in getting it fresh enough for making sections entirely to my satisfaction.

RECENT RESEARCHES *in the* DIATOMACEÆ.[1]
By the Rev. EUGENE O'MEARA, M.A.

(*Continued from page 246.*)

III.

WE come now to consider the most interesting portion of Dr. Pfitzer's valuable contribution to the study of the *Diatomaceæ*, namely, the characteristic arrangement of the cell contents of the different groups, and the changes they undergo during the process of division.

[1] From the 'Journal of Botany,' July, 1872.

Naviculaceæ.

It is to be premised that, according to Dr. Pfitzer's conceptions, this family is very much less comprehensive than preceding writers have regarded it. Several genera hitherto included among the *Naviculaceæ* are by our author separated from it and transferred to other families. *Navicula sphærophora* (Kütz.) is made the type of a new genus, *Anomoeoneis*, and transferred to the *Cymbelleæ*. The reason assigned is that, though the outline is symmetrical, the valves are unsymmetrical, in consequence of a lacuna in the striation on the one side. The same peculiarity is noticeable in *N. sculpta* (Ehren.), and *N. bohemica* (Ehren.), which forms are therefore placed under this new genus. The genera *Donkinia* (Pritch.), *Amphiprora* (Ehren.), and *Amphitropis* (Rab.), by some comprehended in the *Naviculaceæ*, are considered by our author to be a group nearly related to the *Nitzschieæ*, while he regards *Toxonidea* (Donk.) as allied to the *Cymbelleæ*; *Berkleya* and *Rhaphidoglœa* to the *Amphipleureæ*, following in the latter case the suggestion of Grunow; and *Mastogloia*, according to the same authority, to the *Cocconeidæ*. However, he remarks in the case of the last-named genus that, in consequence of the similarity that exists in the structure of the auxospores, it seems more nearly related to the *Naviculaceæ*. In some of these suggested transpositions I feel inclined to concur; there are others, however, which appear to me open to serious objection. Still, further, a new genus is suggested, named *Neidium*, of which I shall speak presently.

Navicula (Bory de St. Vinc.).—The distinctive characteristic of this group is that in the process of cell-division the endochrome plates, advancing along the wall of the cell, move across from the girdle-bands upon the valves, and are there separated by an oblique fissure. Whatever minor differences are observable in the various species of *Naviculæ*, they all agree in this general feature that two mother-cells co-operate in producing two auxospores. The latter term is employed by Pfitzer to designate the result of conjugation, and is suggested by the fact that the sporangial frustule is ever about twice the size of the parent frustules.

Neidium (gen. nov.).—The features in which the species of this genus differ from the *Naviculæ* proper are, first, that the endochrome plates do not move, but are divided while still remaining on the girdle-bands; second, that the process of division is effected, not by an oblique fissure, but one parallel to the longitudinal axis of the cell.

In this genus two mother-cells co-operate to produce two auxospores, as appears from the observations of De Bary, who saw *N. firmum* in "copulation." In this new genus are placed *Navicula firma* (Kütz.), *N. Amphigomphus* (Ehren.), *N. affinis* (Ehren.), *N. limosa* (Kütz.), forms included in Grunow's natural group of *Limosæ*. Whether the circumstances referred to are sufficient to justify the establishment of a new genus, I leave my readers to form their own opinion.

Pinnularia (Ehren.).—This genus was originally distinguished from *Navicula* by the fact that the striæ in the former are uninterrupted or costate, as is the common designation, whereas in the latter they are resolvable into dots. This distinction some later writers consider insufficient, as Grunow, Schuman, Ralfs, Heiberg, Cleve, who have therefore included the species of *Pinnularia* in the genus *Navicula*. Pfitzer, however, re-establishes *Pinnularia* as an independent genus. His observations on the subject are worthy of consideration. The so-called costate striæ of the *Pinnulariæ* were thought by Dippel to be thickened and elevated portions of the siliceous covering. Pfitzer, on the contrary, regards them as depressions of the outer surface of the valve. The structure, though quite observable in the larger forms, as he thinks, such as *P. lata*, is not so manifest in the smaller species, and for this reason he regards the distinction as doubtful. Another distinction attributable to Schuman is noticed, namely, that in the *Naviculæ* the striæ in one direction are of a uniform character, whereas in the *Pinnulariæ*, between the deep broad striæ, fine lines are interposed. These finer lines referred to by Schuman Dr. Pfitzer has never been able to discover, and my experience coincides with his.

The characters on the strength of which the independence of the genus *Pinnularia* is maintained are the unsymmetrical nature of the valves and the peculiar construction of the endochrome plates in the act of division. The former of these characters is open to doubt, as the valves appear generally as symmetrical as those of the *Naviculæ;* the latter feature, however, is noteworthy. In *Pinnularia* the endochrome plates move from the girdle-bands across the valve, as is the case in the *Naviculæ;* but, as occurs in *Neidium*, the fission takes place from the ends in a direction parallel to the longitudinal axis. In this genus two mother-cells produce two auxospores.

Stauroneis (Ehren.).—This genus is distinguished from *Navicula* by the transversely expanded middle nodule, but corresponds with it in the disposition of the cell contents.

Before the cell-division there occurs a movement of the endochrome plates, which are often deeply constricted, and sometimes even interrupted in the middle. *Stauroneis phœnicenteron* has been seen in copulation, and in this case, as observed by Archer, two mother-cells produced but one auxospore.

Pleurostaurum (Rab.).—This genus was established by Rabenhorst in 1859, and thus defined—" Frustula *Stauroneis* sed 3-5-8 in fasciam conjuncta, decussatim striata et a latere visa, vittis longitudina libus flexuosis instructa" ('Flor. Europ. Alg.,' sect. 1, p. 258). To the above diagnosis Pfitzer adds the peculiar unstriated border, somewhat analogous, as he says, to the thickening of the walls occurring in the parenchyma of the leaves of the Pine.

In the structure of the primordial cell *P. acutum* and *P. legumen*, the only species of the genus, correspond with *Navicula*. A central kernel is observable. The condition of the endochrome plates in the process of division has not yet been ascertained.

Pleurosigma (W. Sm.).—This genus, distinguished by the sigmoid form of its valves, as respects its inner structure is closely allied to *Navicula*. In the freshwater species *P. attenuatum* (Kütz.), *P. acuminatum* (Kütz. and Grunow) = *P. lacustre*, W. Sm. (our author says, *P. Spencerii*, W. Sm., but this is an oversight) the endochrome plates are only notched to within a little distance from the margin, just as is the case with the marine species, *P. fasciola*, according to the description of Schultze. The larger marine forms, *P. balticum* (Ehren.), *P. angulatum* (W. Sm.), *P. elongatum* (W. Sm.), *P. decorum* (W. Sm.), have the endochrome plates usually interrupted by the interposition of frequent lacunæ. Long before the division takes place in the case of the freshwater forms of *Pleurosigma*, the endochrome plates are cleft in the middle, so that there are four of them. They then move in pairs across the valves, whereupon the fission of the plasma takes place. Auxospores have not yet been found in the genus *Pleurosigma*.

Frustulia.—Supposing the peculiarities of this group to be so marked as to justify the separation of the forms comprehended in it from the genus *Navicula*, and the establishment of a new genus to receive them, the name *Frustulia* has not been happily selected. The genus *Frustulia* as established by Agardh embraced very heterogeneous forms; and though afterwards considerably narrowed by the author in his 'Systema Algarum,' remained still indefinite. The genus was adopted by Rabenhorst, and was defined ('Süssw. Diat.,' p. 50)

"*Naviculæ* having on the side view longitudinal lines interrupted in the middle without central nodule, nestling in a gelatinous mass." The indefiniteness of this description is not removed by the illustrative figures of the forms. Subsequently the last-named author amended the genus and thus described it:—"Frustula navicularia solitaria vel geminatim —conjuncta, libera vel in muco amorpho nidulantia, valvis elliptico-lanceolatis nodulo centrali terminalibusque destitutis linea media medio interrupta" ('Flora Europ. Alg.,' sect. 1, p. 227). It is doubtful whether the character expressed in these words, "nodulo centrali terminalibusque destitutis," really applies to the forms Rabenhorst embraces in the genus; but if it be correct, it can scarcely agree with Pfitzer's description of the genus *Frustulia* as adopted by him, the characters of which are the strong longitudinal lines placed on either side of the median line, and the very peculiar form of the *nodules*. The arrangement of the internal contents of the cell is in the main the same as in that of the *Naviculæ*, but distinguished by this peculiarity, that the endochrome plates on either side in the middle of the cell are pushed out from the cell-walls by the interposition of a half-spherical mass of plasm. The division of the endochrome plates in the case of *N. saxonica* occurs by fission from the ends throughout, without any movement of the plates within the cell.

The genus as described by Pfitzer has the merit of possessing very distinctive and easily recognisable characters; it is nearly equivalent to the group of *Naviculæ* which Grunow names *Crassinerves*, as also to the genus *Vanheurckia*, adopted by De Brébisson.

As regards the auxospores in this genus, the circumstances are the same as in the *Naviculæ*.

Colletonema and *Schizonema*.—*Colletonema vulgare*, as regards the structure of the cell, very closely approximates *Frustulia*. A central granular plasma-mass and two endochrome plates lying on the girdle-bands are observable here, as are also the two masses of plasma interposed in the middle, between the cell-wall and the endochrome plates. Division of the endochrome plates is accomplished by fission from the ends without any movement of the plates. Other species of *Colletonema*, *C. neglectum*, and *C. eximium*, are more akin to *Navicula* and *Pleurosigma*; and Pfitzer consequently suggests that the genus *Colletonema* should be divided, or, better still, the species it embraces included in *Frustulia* and *Pleurosigma*.

The only species of *Schizonema* which Pfitzer has had the

opportunity of observing in a living state is *S. cruciger*, and in this the circumstances of the movement and division of the endochrome plates were just as in *Navicula*.

In *Colletonema subcohærens*, according to the observation of Thwaites, two mother-cells produce two auxospores, and the process occurs occasionally outside the gelatinous tube. In *Schizonema Grevillii*, according to Smith, one mother-cell produces one auxospore, but according to Lüders this is abnormal, and occurs only when one of the auxospores withers off, the general rule being that two cells co-operate to produce two auxospores.

NOTES AND MEMORANDA.

Correspondence.—GENTLEMEN,—In the XLVIIth number of your excellent Journal are contained two papers, by Mr. W. M. Ord and Mr. George Busk, both claiming for Mr. George Rainey priority in the discovery of the formation of some organic calcareous substances by the action of what he has called *molecular coalescence*, which can be imitated by producing a precipitate of carbonate of lime in the midst of a viscous substance, such as solution of gum arabic or albumen.

I frankly confess that these researches of Mr. Rainey's were entirely unknown to me when I wrote the memoir of which you have already published in your XLVIth number an extract in the form of a preliminary note.

This memoir has been since published, and I have made a point of sending you a copy, which you have probably received. You will consequently be in a position to compare the results of my researches with those previously obtained by Mr. Rainey, and to attribute to each of us what is justly due.

As soon as I became acquainted with the title of the work published by Mr. Rainey in 1858, I hastened to send to London for a copy. I was, in fact, extremely curious to know how far Mr. Rainey's researches, and the results which he deduced from them, coincided with those at which I had quite independently arrived.

Shall I confess it? While acknowledging that Mr. Rainey has excellently described and figured the calcareous globules to which I have given the name of calcosphærites, and that he has clearly pointed out that these globules are found in several products of the organism, such as various concretions, the shell of certain crustaceans, the external layer of the shell of lamelli-branchiata; still, nevertheless, the reading of his work greatly disappointed me, since the praises bestowed upon it by Messrs. Ord and Busk led me to expect more than is found there.

I think, then, that I have no very great reason to regret not being acquainted with it when I resolved to continue the researches which I had already commenced and published twenty years before those of Mr. Rainey, and which I may here be permitted to remark remained quite as unknown to him as his researches to me.

If Mr. Rainey's researches had been previously known to me I should have been under the necessity of refuting the

conclusions which he draws from them on many points, which is always a disagreeable thing to do. The too limited number of his observations on the production of calcareous salts in the midst of organic liquids, and the defective manner in which the experiments were made, have led him to attach a greatly exaggerated importance to "molecular coalescence;" the part played by which is much more limited than he supposes, and is confined to those cases where calcosphærites are produced in a limited space, and come into mutual contact, enlarging each one for itself in the same manner as crystals. I shall not discuss the numerous points of difference between Mr. Rainey's views and mine. That would lead me too far, and I can leave this task to other persons who may be willing to repeat the experiments and observations which I have described. Nevertheless all this by no means implies that I have not read with much interest Mr. Rainey's observations and the considerations by which they are accompanied. Certainly there are to be found there many excellent ideas which must be well weighed by those who may wish to continue this kind of research. Moreover, I regard it as one of the good results of publishing my researches, to have contributed to rescue from an undeserved oblivion those of a naturalist whose high merits I have pleasure in acknowledging.

Your obedient servant,

UTRECHT, *July 24th*, 1872. P. HARTING.

A New Medical Microscopical Society.—We have been favoured by a circular which we reprint below, and may say that the proposition appears to us to be a thoroughly practical and useful one, which should lead to a satisfactory result.

"As none of the existing Microscopical Societies meet the wants of the student of medicine, it is proposed to establish a new Society, which shall devote itself *solely* to microscopical subjects *in intimate relation with man*, both in health and disease. The objects of the proposed Society will be the Reading and Discussion of Papers; the Exhibition of Specimens; the Formation of a Cabinet; the Exchange of Specimens, &c. A preliminary meeting, of which due notice will be sent to the various Hospitals and Medical Journals, will be held early in October, for the formation of the Society, the enrolment of members, the drawing up of rules, the election of officers, and for other business; and it is hoped that all *qualified medical gentlemen and registered students* interested in the movement will attend.

"All questions with regard to fees, hour and place of

meeting, subjects admissible for Papers, &c. &c., will, of course, be settled at the preliminary meeting.

"(Signed) J. W. GROVES,

"*St. Bartholomew's Hospital, Smithfield, E.C.*

"To whom all communications should be addressed."

Models of Vertebrate Blood-corpuscles.—A series of twelve models in a case is to be had from Herr G. Klautsch, assistant in the anatomical institute of Halle, for six thalers, illustrating the relative dimensions of the red blood-corpuscle in various vertebrata. Prof. Welcker, in 'Schultze's Archiv,' 3rd part, 1872, gives an account of the physiological and zoological facts which may be rendered evident by the use of these carefully prepared models. All the models of the corpuscles are prepared on the same scale, namely, five thousand times the natural size. The animals represented are musk-deer, goat, llama, man, chaffinch, lizard, frog, proteus and tench.

The following are abstracts of communications made to the Biological Section of the British Association at Brighton:

1. **On the Structure and Development of Mitraria.** By Prof. Allman, F.R.S.—Several specimens of the remarkable larval form, to which John Müller gave the name of *Mitraria*, were obtained by Prof. Allman in the Gulf of Spezzia, and were made the subject of careful study of structure and development. Mecznikoff had recently examined another species of the same form, and the author was enabled to confirm the main result arrived at by him, that *Mitraria* was the larval form of an annelid. In some fundamental points, however, regarding the process of development, his observations did not agree with those of the Russian zoologist, while in structure there are some important features which have not been described by either Müller or Mecznikoff, differences which may, in some cases at least, depend on actual differences between the species examined.

The nervous system is well developed, and consists in the principal central portion of a large quadrilateral ganglion, formed by the union of two lateral ones, and situated on the summit of the transparent dome-like body of which the larva mainly consists. From this two very distinct cords are sent downwards, so as to form a pair of commissures with two small ganglia, which are situated at the opposite side of the alimentary canal. Besides these, two other small ganglia exist in the walls of the dome, at the oral side of the great apical ganglion, and two similar ones at the ab-oral side. These send off numerous filaments, which dive at once into

the walls of the dome, while each sends off a long filament to the region where the alimentary canal begins to bend downwards towards its ab-oral termination. The great apical ganglion supports two sessile ocelli, with pigment and lens, and two small spherical vesicles, each containing a clear spherical corpuscle. These last the author regards as auditory capsules.

A system of vessels was also described. This consists mainly of a sinus which surrounds the great apical ganglion, and sends off three branches, which run in a radial direction in the walls of the dome, two lateral and one ab-oral, and appear to open into a sinus which surrounds its base.

In the progress of development the ab-oral end of the alimentary canal becomes elongated in the direction of the axis of the dome, carrying with it the walls of the base of the dome, which are to form the proper body walls of the future worm, and in this way a long cylindrical appendage becomes developed, and hangs from the central point of the base. At first there is no trace of segmentation, and this is subsequently induced on the cylindrical body of the worm by the formation of consecutive annular constrictions.

The process of development, as observed by the author in the species of *Mitraria* examined by him, thus differs in several points from that observed by Mecznikoff. Among these the most important is that the ventral side of the worm is formed simultaneously with the dorsal instead of subsequently to it and independently of it, as in the case described by Mecznikoff. The development of the worm was not traced to the ultimate disappearance of the dome-like body of the larva.

2. On some Points in the Development of Vorticellidæ. By Prof. Allman.—The author described, in a beautiful branched and clustered vorticellidan, a process different from any which had been recorded by those observers who had described the so-called every day process, and the behaviour of the "nucleus" in the Vorticellidæ.

In almost every cluster some of the zooids composing it had become greatly altered in form. They had increased in size, and instead of the bell-shaped form of the others had assumed a globular shape, and had lost both oral orifice and ciliary apparatus, while their supporting peduncle had ceased to be contractile. In the younger ones the contractile space of the unchanged zooid was still very evident, but was fixed, showing no tendency to alteration of size, and the so-called nucleus was very distinct and larger than in the ordinary zooids. The whole was enveloped in a transparent gelatinous-looking investment.

In a slightly more advanced stage another envelope, in the form of a brown horny capsule, begins to be secreted between the proper wall of the zooid and the external gelatinous investment. It is at first thin and smooth, but it gradually acquires considerable thickness, and becomes raised on its outer surface into ridges enclosing hexagonal spaces.

In this stage the capsule has become too opaque to admit of a satisfactory view into its interior; but if the capsule be carefully opened its contents may be liberated so as to render apparent their real nature. It will be then seen that these consist of a minutely granular semifluid plasma surrounding the "nucleus," which has much increased in size and occupies a large portion of the cavity of the capsule. The condition of the contractile space could not be determined; it has probably altogether disappeared.

In a further stage the "nucleus" has undergone an important change; for, instead of the long cylindrical form it had hitherto presented, it has become irregularly branched, has acquired a softer consistence, and has moreover broken itself up into two or more pieces. This change in the "nucleus" is invariably accompanied by the appearance of nucleated cell-like bodies, which are scattered through the corp uscula plasma which had filled the rest of the capsule. They are of considerable size, of a spherical form, and with their nucleus occupying the greater part of their cavity, and having its nucleolus represented by a cluster of granules.

In other capsules, apparently the more advanced, no trace of the so-called nucleus of the vorticella body could be detected, and it seems to be entirely replaced by the spherical nucleated cells, which had now still further increased in number. It is impossible not to regard these cells as the result of the disintegration of the nucleus, and the conclusion is a legitimate one, that they are finally liberated by the natural dehiscence of the capsule, and become developed into new vorticellidans.

3. On the Structure of Edwardsia. By Prof. Allman.—The structure of this beautiful little actinozoon differs in many important points from that of both the zoantharian and alcyonarian polypes. It was shown that just within the mouth the walls of the stomach-sac project into the cavity of the sac in such a way as to form eight complicated frill-like lobes; that the eight vertical, radiating lamellæ which project into the body cavity from the outer walls, and are composed of parallel longitudinal fibres enclosed between two membraneous layers, do not reach the stomach-sac in any part of their course, and that eight strong muscular bundles

pass symmetrically through the whole length of the body cavity, being attached at one end to the disc which carries the tentacles, and at the other to the floor of the body cavity, while they are free in their intervening course.

Attached along the length of about the posterior half of each muscular bundle is the long sinuous generative band, with its chord-like craspedum loaded with thread cells. Just before terminating at the lower opening of the stomach-sac each of the eight generative bands enters a most remarkable pectinated organ, which appears to be quite unrepresented in any other group of the *Cœlenterata*. It was difficult to suggest the true significance of these organs; their relation to the generative bands might lead to the belief that they are testes, or they may be analogous to the so-called cement glands which exist near the outlet of the oviducts in some of the lower animals. In this case they might supply some additional investment to the ova at the time of extrusion.

The author regarded *Edwardsia* as presenting a very distinct type of actinozoan structure which occupies an intermediate position between that of the zoantharian and that of the alcyonarian polypes. He also compared it with the extinct rugose corals of the palæozoic rocks to which it corresponds in the numerical law of its body segments, and of which it might in some respects be regarded as a living non-coralligenous representation.

4. **On the Structure of Cyphonautes.** By Prof. Allman.—This remarkable little organism, whose structure and ultimate destination have been variously described by different observers, was obtained by the author in considerable abundance in Moray Firth. The animal is enveloped in a mantle, and the whole enclosed in a delicate, transparent, structureless test formed by two valve-like triangular plates, which are in contact along two edges, and separated from one another by a narrow interval along the third. Its form is thus that of a very much compressed cone or pyramid. The author distinguishes by the term base the broader edge, where the two plates of the test are separated from one another; while the other two edges are distinguished as the anal and ab-anal edges. The apex is the angle opposite to the base, and here a narrow passage exists through which the fleshy walls of the mantle are brought into immediate contact with the surrounding water.

In the base are two large oval openings, one, the larger, situated towards the anal edge, and the other towards the ab-anal. The former leads directly into the cavity of the mantle. Its edges are prolonged by a membranous lobe

ciliated on its margin, and uninterruptedly continued round the anal side of the opening, but deficient on the opposite side. The interior of the lobe is occupied by a cavity.

A large part of the mantle cavity is occupied by the pharynx, a spacious thin-walled sac which opens into the mantle cavity by a long curved slit with thickened and ciliated margins, which, at the ab-anal side, are continued beyond the opening in the base in the form of two short ciliated tentacles. Towards the apex the pharynx becomes suddenly narrow, and is here lined by vibratile cilia, and marked by circular striæ, which possibly indicate the presence of sphincter-like fibres. It now turns towards the anal side, and then bends downwards towards the base, and enters a thick-walled sub-cylindrical stomach. This runs towards the base parallel to and a little within the anal edge of the test, and is ultimately continued into a short straight intestine, which terminates by an anal orifice on the mantle cavity near the outer opening of the latter. From the upper part of the walls of the pharynx a narrow bundle of fibres passes to the apex of the mantle cavity.

Upon each side of the pharynx and lying against the stomach and intestine is a large oval mass. Its situation would suggest the probability of its being an hepatic organ, but it is altogether so enigmatical that it would be rash to insist on assigning to it any special significance.

In contact with each of these enigmatical organs is a small tubercle, from which a bundle of short fibres pass off in a radiating direction. The resemblance of these bodies to a pair of nervous ganglia is obvious, but the author was more inclined to regard them with Schneider as indicating points of attachment of the contained animal to the two valves of the test.

The smaller of the two openings in the base, that, namely, which is situated near the ab-anal edge of the animal, is, like the other, surrounded by a hollow membranous lobe with ciliated margin. This is uninterruptedly continued round the ab-anal side of the opening, but is deficient on the opposite side. The opening leads into a special chamber, entirely shut off from the cavity of the mantle and from the pharynx. The walls of the chamber are lined with cilia, and it has within it, or in immediate connection with its walls, two peculiar structures. One of these is a somewhat pyriform organ, which, with one end close to the orifice of the chamber, extends from this point into its cavity; it is composed of a mass of spherical bodies. The other extends over the roof of the chamber in form of a cap; it consists of two portions, one of which lies directly on the walls of the

roof, and has a transversely laminated structure, which, however, disappears towards the ab-anal side of the chamber; the other is an oval mass of globular cell-like bodies, and lies on the free convex surface of the laminated portion.

Here, again, this part of the *Cyphonautes* is in the highest degree enigmatical, and yet it is difficult not to believe that in the structures just described we have an ovary and testis with associated accessory structures.

The author observed no further fact which might tend to throw light on the ultimate destination of *Cyphonautes*, and more especially nothing which might tend to confirm the remarkable news lately published by Schneider, who believes that he has traced its development into the polyzoon *Membranipora pilosa*. The structure is considerably more complicated than Schneider seems to be aware of, while the opinion of this observer, that the whole of the proper *Cyphonautes* structure becomes absolutely obliterated and the body of the animal converted into an amorphous mass of cells from which the *Membranipora* becomes evolved, is so startling as to compel us to wish for further confirmation of the evidently careful observations of the German zoologist.

If the ab-anal chamber described above, with its associated structures, really belongs to the generative system—and it is hard to say what else it can be—the view that *Cyphonautes* is a polyzoal larva is scarcely tenable.

5. On a Radiolarian Rhizopod from the Coal Measures. By W. Carruthers, F.R.S.—In the investigation of a large series of sections prepared by Mr. Norman, the author had detected several spherical spiniferous bodies, not unlike *Xanthidia*, but having a very different structure and a much greater size. The hollow globular cavity is enclosed in a clearly defined structure, which the author thought is a fenestrated shell, but he had not been able to secure sections which completely established this point. Beyond this there is a considerable thickness of a spongy substance which rises externally into numerous cones, the bases of which are in close proximity. From the base of each cone there proceeds a hollow echinate spine. The echinations are also hollow, and at the apparent base of the spines these echinations are produced into hollow tubes which are repeatedly branching and anastomosing, and, increasing in number downwards, enclose the radial hollow spire in the mass. The whole arrangement of the parts agreed with what is found in some existing forms of Radiolarians, especially in some with solid spines. But the hollow structure of these organisms indicated relations with a small section of the recent

group. No certain indication had yet been detected of the central capsule, but Mr. Carruthers, having found the structure of starch and other readily perishable substances fully preserved in some fossils, had hopes that the central capsule may have left traces behind in some specimens. Rhizopods of the Radiolarian type, but without the central capsule, had been described by Cienkowskil and especially by Archer. Perhaps amongst them this Palæozoic form may at last be placed. One would expect it to be a fresh water organism, yet it might, as a marine animal, indicate one of those changes of level which were not infrequent in the Carboniferous period. The author had associated with this interesting animal the name of his friend Prof. Traquair, of Dublin, to whom he was indebted for assistance in working out its structure. He proposed to name it *Traquairia.*

Sir John Lubbock remarked, that though as Mr. Carruthers had stated there was no evidence hitherto of the existence of Radiolarians prior to the chalk, yet as they belonged to a lowly organised type their appearance low down in the geological series was only what might reasonably be expected to occur.

Prof. Thiselton Dyer said that this was one of the most interesting papers which had been brought before the section. When Mr. Carruthera first showed him the specimens, they immediately recalled to his mind the *Xanthidia* of the chalk. It was abundantly evident, however, from the details of structure which Mr. Carruthers had worked out, that they had nothing to do with those organisms which had been compared with the zygospores of *Desmidieæ*, but were more probably resting stages of some animal organism.

6. Report of the Committee appointed for the purpose of Promoting the Foundation of Zoological Stations in different parts of the World, consisting of Prof. Rolleston, Dr. Sclater, Prof. Huxley, Prof. Wyville Thomson, Mr. E. Ray Lankester, and Dr. Dohrn.—The Committee beg to report that, as stated in the report of the last meeting, the Zoological Station at Naples will be ready and in working order at the beginning of January, 1873, the progress of the construction being such as to enable Dr. Dohrn to make this assertion.

This undertaking has received much official and private assistance, not only from public authorities, but in a very high degree from private persons. The Committee feel obliged to acknowledge especially the extraordinary services rendered by M. W. A. Lloyd of the Crystal Palace Aquarium in giving every assistance to Dr. Dohrn in as far as technical difficulties are concerned.

Special care has been taken to secure donations to the library of the Station. The eminent firm of Engelmann in Leipsig has presented all its works on biology not previously possessed by Dr. Dohrn. Reweg in Brunswick has also sent all his publications on biology. Theodor Fischer in Cassel has done the same. Important donations are promised by Dr. Alexander Agassiz of Cambridge, Mass., comprehending the publications both of his father and himself.

To secure the development of the library on a greater scale, it will be necessary to make general applications. For this purpose Dr. Dohrn, assisted by several of the greatest German publishing firms, is preparing an appeal to all German publishers, and he hopes also to succeed with a similar demand in Italy. The Committee hope that the British Association will lend its moral support to a similar demand in this country, not only by granting a complete set of its own publications, but by recommending a similar act to other scientific bodies and private persons.

The Committee are further glad to announce that some steam-navigation companies are prepared to grant a free passage to the naturalists and free transport for the goods to and from the Station. As transactions are still pending between these companies and Dr. Dohrn, the latter does not think it desirable to publish details on this point, or to mention the names of the companies in question.

Dr. Dohrn contemplates a new step for the purpose of returning a larger income for the Naples Station. He is about to offer to several governments, universities, and scientific bodies, working tables in the laboratory of the Station for a certain annual sum. This sum would confer on the subscribing government, university, or society, the right of appointing a naturalist, who, on presenting a certificate to the administration of the Station, would be furnished with a working table, and admitted to a participation in all the very extensive advantages of the Station.

The Committee think well earnestly to advocate this new step of the administration of the Naples Station, the more as it lessens the burden of the single naturalist, enabling even such as are destitute of means to profit by the manifold advantages of the Station, while it secures a fixed income to the Station which would be employed in improving the technical and other means of investigation.

Mr. Lankester gave some additional account of the Zoological Station about to be established by Dr. Dohrn at Naples. During the present year he had personally had the opportunity of seeing the arrangements which were in progress.

The following is an extract from the correspondence of the 'Spener Gazette' of Berlin:

"On the narrow strip of coast which separates the park of the Villa Reale from the sea, a large stone building is at present being erected at Naples, quietly and almost unnoticed—at least the Neapolitan press has paid no attention to it. The strength of the foundations—it has taken three months to lay them—shows that they are intended for an edifice of considerable size and durability; and on making inquiries I have learnt that this is the Zoological Station, which has been occasionally mentioned by Italian, German, and English journals during the last few months. It has been organized and is being built by a young German naturalist, Dr. Anton Dohrn, of Stettin, who, until a few years ago, was a *private docent* at the University of Jena. He has paid nearly the whole of the expenses, which amount to about 50,000 thalers (£7500), out of his own pocket, the only assistance he has received having come from a few personal friends, who have lent several thousands of thalers for the purpose. The following is a short sketch of his plan: —The ground floor of the building, which covers an area of almost 8000 square feet, contains a great aquarium, which will be opened to the public. Dr. Dohrn hopes that the money thus obtained will not only suffice for all the expenses of the aquarium, but also afford a surplus to be employed in covering a part of the requirements of the upper story, which is to be exclusively devoted to scientific purposes. Besides the officials and servants employed in the aquarium, several young zoologists will be attached to the Station, and receive a regular salary from the director, Dr. Dohrn. Thus, a number of new positions will be opened up for young scientific men. But this is not all. As the only duty of these zoologists will be to devote themselves to certain branches of scientific work, and their exertions will be carefully directed and organized, as has long been the case in astronomical and meteorological observatories, there is every reason to hope that scientific research will be greatly facilitated and advanced by their labours. In the upper story of the Zoological Station laboratories will also be prepared for the use of naturalists coming from other parts of Italy and from abroad. For this purpose a large scientific library will be founded, Dr. Dohrn's very considerable private collection serving as a nucleus, and about twelve tables, fully furnished with the necessary appurtenances, established. Each of the latter will be provided with a number of tanks supplied with a constant stream of sea-water. Sea-fishing and dredging will be conducted on

an extensive scale by means of several boats, to which, if the necessary means are forthcoming, a small steam-yacht will be added. The animals taken will be given to the zoologists for scientific treatment. It is more than doubtful whether all these rich and expensive conveniences can be furnished to zoological visitors without any pecuniary compensation; but I hear that Dr. Dohrn has drawn up a plan which will enable even naturalists of limited means to enjoy the advantages of the Station. He proposes to offer one or more tables to various governments and scientific societies for a fixed annual sum. These tables, and all the scientific resources of the Station, will at once be placed at the disposal of any naturalist who brings a certificate from the government, university, or scientific body to which the table has been let. This plan, among its many other advantages, seems to be a successful attempt to solve the difficult question as to how it is possible to unite a complete self-administration on the part of scientific bodies with the reception of pecuniary assistance from their governments.

"Dr. Dohrn speaks in the most grateful manner of the assistance rendered him by the German authorities in Italy, especially by Mr. Stolte, the consul-general at Naples, while at the same time he warmly acknowledges the interest in his undertaking displayed by the government of Italy, more particularly Signor Correnti and Signor Sella, the late and the present Ministers of Public Instruction. The difficulties in the way of the execution of his plan were neither few nor small, as may be gathered from the fact that, in spite of the readiness (?) displayed by the municipal authorities of Naples, more than two years elapsed before a definitive contract could be concluded between the town and Dr. Dohrn with respect to the cession of a suitable site for the building."

7. Fourth Report on the Fauna of South Devon. By C. Spence Bate.—Attention had been principally directed to the development and habits of animals which had fallen under observation. This had been facilitated by the establishment at Plymouth of a marine pond as store for the Crystal Palace Aquarium. The observations had already proved interesting, and would become more so as the conditions of the pond became better adapted to deep-sea species. It is formed out of a deep gulley in the limestone, partly extending back into a cave. At the entrance it is 11 ft. wide, and in other parts more than double; when the water is highest, its length is upwards of eighty feet. With the replacement of the original *Fucus* by green algæ, the water has become pellucid and clear. A list was given of the fish

taken on the coast since the last report. Most of these have done well in the pond, the exceptions being fish of erratic habits, such as the mackerel. These, after restlessly roaming in search of an outlet, succumbed and died. Other fish thrive apparently unconscious of their confinement. The Blue Wrasse (*Labrus mixtus*) had exhibited marked sexual selection, a fact which had also been observed by Mr. Lloyd at Hamburg. During the breeding time the male selects one out of many females, and afterwards regularly accompanies her. It had also been ascertained that the Blue Wrasse and the Spotted Wrasse were the same species. The male in confinement at Plymouth appears to be losing his fine colouration and approximating to that of the female; it seems, therefore, probable that the blue colour is more or less assumed at the breeding season.

With regard to the crustacea, there are two subjects of interest. The first is the perceptible decrease in the numbers of the edible species, the decrease being more perceptible in the littoral than in the deep-sea species. This arises from the custom of destroying the females as well as the males at all seasons of the year, and also from the preference given to the lobster for culinary purposes when laden with spawn. In the case of the crab (*Cancer pagurus*) there is not even this excuse. The marketable value of the female is at least one fifth that of the male. This arises from the smaller size, especially of the claws. Captured in greater numbers, they are wantonly destroyed, being hawked about the streets for a few pence. The capture of the lobster, he thought, should be interdicted from February until May, and that of the female crab altogether. To the assertion that the lobster and crab are so prolific as to render the destruction unimportant, there was the obvious reply, that in all those forms of life where the ova are not abundant, the development of the individuals is least quantitatively. In the case of the lobster, no one has ever seen that stage in its life which unites the animal as we know it with that which we have seen it when it quits the egg, and, except the common littoral crab (*Carcinus mænas*), this is true of all the higher crustacea. Mr. Lloyd, of Hamburg, has noticed that the male of the soldier crab (*Pagurus*) in the spring takes hold of the shell containing the female, and carries it about for weeks together, and does not intercept its food as it would if a male were contained inside. He had found that crustacea might be preserved in a very superior way by keeping them in glycerine, and then drying them. Specimens preserved in this way two or three years ago were as flexible as if fresh. The soft parts should, if possible, be re-

moved. He hoped to preserve fish in the same way. (Mr. Spence Bate subsequently remarked that after five or six years the structure of specimens preserved in glycerine appeared to become rotten. He suggested, therefore, the previous admixture with the glycerine of one eighth of spirit of wine.)

Among the molluscs many specimens of *Eledone* had been captured. This was generally supposed to be a rare species, but *Octopus vulgaris* proves to be the more difficult to obtain. Two specimens of *Sepia officinalis* were placed in the pond on the 8th of June 1871. On the 24th they were seen to be in *copulá*, head to head, arms interlaced, and resting on the bottom for about twelve minutes. On the 12th July the female died, and was found to contain a large quantity of ova. Steps have been taken to have constructed in the cave behind the pond a case with a glass front for watching the habits of animals. The temperature of the water in the pond is several degrees below that in the tanks at the Crystal Palace.

8. On the Relative Power of Various Substances in Preventing Putrefaction, and the Development of Protoplasmic and Fungus Life. By Dr. F. Crace-Calvert, F.R.S.—To carry out this series of experiments, small test tubes were thoroughly cleansed and heated to dull redness. Into each was placed 26 grammes of a solution of albumen, containing one part of white of egg to four parts of pure distilled water, prepared as described in my paper on "Protoplasmic Life." To this was added $\frac{1}{1000}$, or ·026, gramme of each of the substances the action of which I desired to study.

The reasons why I employed one part in a thousand are twofold. First, the employment of larger proportions would in some instances have coagulated the albumen; secondly, it would have increased the difficulty of observing the relative powers of the most efficacious antiseptics in preventing the development of the germs of putrefaction or decay.

A drop was taken from each of the tubes, and examined under a microscope having a magnifying power of 800 diameters. This operation was repeated daily with the contents of each tube for thirty-nine days, and from time to time for eighty days. During this time the tubes were kept in a room the temperature of which did not vary more than three degrees, namely, from 12·5° C. to 15·5° C.

In order the better to show the influence of the antiseptics used, I examined two specimens of the same solution at the same time, one of which was kept in the laboratory, the other in the open air.

A marked difference was observed in the result, the one kept outside becoming impregnated with animal life in less than half the time required by the other, while as many

vibrios were developed in six days in the tube kept outside as were developed in thirty days in the tube in the laboratory.

A summary of the results of the experiments is given in the following table, in which the substances are grouped according to their chemical nature:

	Days required for development of— Fungi.	Vibrios.	Days required for the development of putrid odours in albumen kept at 80°.
1.—*Standard Solutions.*			
Albumen kept in laboratory for comparison	18	12	16
Albumen exposed outside laboratory .	None.	5	—
2.—*Acids.*			
Sulphurous acid	21	11	45
Sulphuric acid	9	9	16
Nitric acid	10	10	16
Arsenious acid	18	22	None.
Acetic acid	9	30	None.
Prussic acid	None.	9	35
3.—*Alkalies.*			
Caustic soda	18	24	72
Caustic potash	16	26	85
Caustic ammonia	20	24	26
Caustic lime	None.	13	14
4.—*Chlorine Compounds.*			
Solution of Chlorine	22	7	16
Chloride of sodium	19	14	16
Chloride of calcium	18	7	11
Chloride of aluminum	21	10	16
Chloride of zinc	53	None.	38
Bichloride of mercury	81	None.	None.
Chloride of lime	16	9	9
Chlorate of potash	19	17	38
5.—*Sulphur Compounds.*			
Sulphate of lime	19	9	14
Protosulphate of iron	15	1	16
Bisulphite of lime	18	11	16
Hyposulphite of soda	18	11	11
6.—*Phosphates.*			
Phosphate of soda	17	13	16
Phosphate of lime	22	7	16
7.			
Permanganate of potash	22	9	11
8.—*Tar Series.*			
Carbolic acid	None.	None.	None.
Cresylic acid	None.	None.	None.

	Days required for development of— Fungi.	Vibrios.	Days required for the development of putrid odours in albumen kept at 80°.
9.—*Sulphocarbolates.*			
Sulphocarbolate of potash	17	18	35
Sulphocarbolate of soda	19	18	26
Sulphocarbolate of zinc	17	None.	None.
10.			
Sulphate of quinine	None.	25	None.
Picric acid	19	17	26
Pepper	None.	8	16
Turpentine	42	14	35
11.			
Charcoal	21	9	None.

In comparing the results stated in the above table, the substances can be classed under four distinct heads, viz. those which prevent the development of protoplasmic and fungus life; those which prevent the production of vibrio life, but do not prevent the appearance of fungus life; those which permit the production of vibrio life, but prevent the appearance of fungus life; and those which do not prevent the appearance of either protoplasmic or fungus life.

The first class contains only two substances—carbolic and cresylic acids.

In the second class, also, there are only two compounds—chloride of zinc and bichloride of mercury.

In the third class there are five substances—lime, sulphate of quinine, pepper, turpentine, and prussic acid.

In the fourth class is included the remaining twenty-five substances.

The acids, while not preventing the production of vibrio life, have a marked tendency to promote the growth of fungus life. This is especially noticeable in the case of sulphuric and acetic acids.

Alkalies, on the contrary, are not favorable to the production of fungus life, but promote the development of vibrios.

The chlorides of zinc and mercury, while completely preventing the development of animalcules, do not entirely prevent fungus life; but I would call special attention to the interesting and unexpected results obtained in the cases of chlorine and bleaching-powder. When used in the pro-

portion above stated they do not prevent the production of vibrio life. In order to do so they must be employed in excess; and I have ascertained, by a direct series of experiments, that large quantities of bleaching-powder are necessary. I found that part of the carbon was converted into carbonic acid, and part of the nitrogen was liberated.

If, however, the bleaching-powder be not in excess, the animal matter will still readily enter into putrefaction. The assumption on which its employment as a disinfectant has been based, viz. that the affinity of the chlorine for hydrogen is so great as to destroy the germs, is erroneous.

The next class to which I would call attention is the tar series, where neither the carbolic nor the cresylic acid fluids gave any signs of vibrionic or fungus life during the whole eighty days during which the experiments were conducted.

The results obtained with sulphate of quinine, pepper, and turpentine deserve notice. None of them prevents the development of vibrio life; but sulphate of quinine and pepper entirely prevent the appearance of fungi. This fact, together with the remarkable efficacy of sulphate of quinine in intermittent fever, would lead to the supposition that this form of disease is due to the introduction into the system of fungus germs; and this is rendered the more probable if we bear in mind that these fevers are prevalent only in low, marshy situations, where vegetable decay abounds, and never appears to any extent in dry climates, even in the midst of dense populations, where ventilation is bad and putrefaction is rife.

The results obtained in the case of charcoal show that it possesses no antiseptic properties, but that it prevents the emanation of putrid gases, owing to its extraordinary porosity, which condenses the gases, thus bringing them into contact with the oxygen of the atmosphere, which is simultaneously condensed.

The above results have been confirmed by a second series.

A series of experiments was also undertaken, substituting gelatine for albumen, and was continued for forty-seven days.

9. **Note on certain Phenomena of Coagulation which are observable in Frog's Blood.** By Mr. Schäfer, of University College.—I was endeavouring in the autumn of last year, at Professor Sanderson's instigation, to demonstrate upon the frog some of Brücke's fundamental experiments on the coagulation of the blood, experiments which he performed on the tortoise; I was surprised at the apparent failure of some of them. For instance, having tied a glass tube into the animal's aorta and allowed it to fill with blood, I expected that which was in the tube speedily to

coagulate, that which remained in the heart to continue liquid for a considerable time. But no such contrast was observable, both portions of blood remained perfectly fluid for an indefinite time. I say apparently, for, in fact, on subsequently turning out the blood, a slight film of coagulated fibrin was observable attached to the walls of the tube. Of course the corpuscles being the heavier gravitate to the bottom, and the blood thus becomes divided into two portions, a clear fluid above and a mass of red corpuscles below, with a thin filmy stratum of white again on the surface of the latter.

To show that the clear fluid is plasma and not merely serum, that is to say, that it fully retains its coagulability, it is sufficient to take a little up into a very fine, almost capillary, glass tube. The extent of surface to which it is thus exposed very quickly determines its coagulation.

Following up the subject still further, I found the same thing to happen when the blood is allowed to drop into a glass vessel: the whole remaining fluid, except that portion in immediate contact with the sides, the corpuscles subsiding as before, the supernatant liquid being readily coagulable in a capillary tube.

But frog's blood does not always behave in this manner. It is not unfrequently the case, especially at this season of the year, to find that the blood of these animals behaves to all appearance precisely as we are in the habit of expecting that blood should behave, that is to say, the commencing subsidence of the corpuscles is arrested, the fluid solidifies, seemingly throughout. And, indeed, in rare instances, the coagulation is complete to the centre, and the mass soon separates into clot and serum, which latter, in these cases, never yields a coagulum in a capillary tube. More frequently, however, on breaking the surface with a knife, the interior of the coagulated mass is seen to be occupied by still fluid blood.

In either case, the coagulated fibrin soon begins to contract; and this contraction proceeds to such an extent that not only is the serum of the blood expressed from it, but it comes to pass that there is no longer room in its meshes for the involved corpuscles, which consequently begin to be squeezed out and to fall to the bottom of the glass. This diminution in volume of the clot may proceed so far that in the course of a few hours the blood may present an appearance precisely as if it had not undergone coagulation at all, there being a mass of corpuscles at the bottom of the vessel, and a clear supernatant fluid. The contracted remains of the

clot may however be always found, although often obscured by the liberated corpuscles. Now, this disappearance of the clot of frog's blood under certain circumstances was noticed some years ago by v. Recklinghausen, and ascribed by him to a reliquefaction of the fibrin; and not unnaturally, if we consider the astonishing diminution in bulk which it undergoes, and the fact that the serum in such cases is frequently found to yield a further coagulum.

But in every case of the latter kind, *i. e.* in every case in which the supernatant fluid yields a coagulum in a capillary tube, it will have been found that the primary coagulation was incomplete, *i. e.* that the central parts of the blood remained fluid, whereas on the other hand it is certain that when the primary coagulation has been complete, no further coagulum is *ever* obtainable, although, in this case also, the clot may have contracted to a relatively exceedingly small bulk, in fact, may have almost disappeared.

A further proof, if one were needed, that the diminution of the clot is due merely to contraction and not reliquefaction of fibrin is to be found in the examination under the microscope, using an immersion objective, of the process as it occurs in a very thin-walled and fine capillary glass tube.

The phenomena here observed are wholly those of contraction, first simply serum, then white corpuscles, and finally red corpuscles being expressed, until a mere thread of fibrin remains, almost obscured by the corpuscles and still including a few.

Throughout the whole process, however, there is no trace of a reliquefaction of fibrin; this would of course involve the dropping away of the corpuscles from the sides: on the contrary, they are most evidently squeezed out, some of them being actually ruptured in the passage and appearing on the exterior of the clot as small reddish spheroids. The facts then, briefly, are these: that frog's blood, especially if taken during the winter months, exhibits but very little tendency to coagulate, with the exception of the portion in immediate contact with a foreign surface; that, when apparently coagulated throughout, the central portions are very apt to remain fluid, and to impart coagulability to the expressed serum; that the clot when formed frequently tends to attain a relatively very small bulk; and, finally, that this diminution in bulk is due to contraction merely, not reliquefaction of the fibrin.

QUARTERLY CHRONICLE OF MICROSCOPICAL SCIENCE.

MICRO-ZOOLOGY AND EMBRYOLOGY.

Sponges.—The discussion concerning the affinities of sponges, which was started by Professor Haeckel's investigations of the calcareous group of that class of organisms and by his demonstration of their many points of contact with the Cœlenterata, has now reached a further stage. On the one hand, Haeckel and Eimer have adduced fresh evidence for the association of the sponges with the Cœlenterata, whilst, on the other hand, James Clark, encouraged by the confirmatory observations of Carter, has endeavoured to strengthen his assimilation of the former to compound flagellate infusoria.

In a paper entitled "The American Spongilla, a Craspedate Flagellate Infusorian," in the 'American Journal of Science and Arts,' Dec., 1871, Professor Clark describes the structure of young specimens of a Spongilla, which he terms *Spongilla arachnoidea*. He recognises a circulatory chamber or series of cavities (in place of the branched canals ordinarily observed in Spongilla) into which open large efferent (one only in the smallest specimens) and smaller afferent ostioles. The tissue of the walls of this chamber is composed of a structureless cytoblastema, to which the contractility of the Spongilla is ascribed. In it are scattered numerous oval or round nucleated cells. The tissue thus formed is supported by spiculæ, which raise up portions of it so as to form the cavity of the circulatory chamber, the roof of the chamber perforated by ostioles hanging from the spiculæ like the canvas of a tent from its poles. The floor presents numerous openings which lead into small spherical cavities, the "ampullaceous sacs" of Carter, densely lined with ciliated monads. Professor Clark does not regard these ciliated monads as performing a general circulatory function. He considers that the contractility of the walls of the large chamber, and that of the efferent ostioles, is sufficient to carry on that process. The ciliated monads, in their nearly closed sacs, are said to be the "heads" of the sponge, which is a polycephalic organism, the ciliary movement of their flagella serves only to bring the water carrying food from the general cavity to them. The monads are stated to possess a 'collar,' such as the author described in *Leucosolenia*, and in certain free monads; but—why is not very clear—they are distinctly declared not to be cells. It is on the strength of

the existence of such collar-bearing monads as these in parts of the organism of some sponges, that Professor Clark objects to the explanation by Haeckel of the structure of far more complicated members of the class, by reference to the polyp-type. He does not seem to see that whilst it is quite conceivable that such forms of cells as 'collar-bearing monads' should develop in parts of almost any organisms—just as amœboid cells, beaker-cells, flagellate cells, and a host of other forms do—his insistance upon this point of structure as conclusive of a relationship to flagellate infusoria leaves the whole problem offered by the compound structure of the calcareous and other sponges untouched. On the other hand, this problem is dealt with, and the sponges are brought into an intelligible position, by the mode of view advocated by Haeckel, which view, by-the-bye, is that advanced many years since by Leuckart and by Van Beneden, who said "the sponge presents us with the prolyp-type reduced to its simplest expression."

Eimer (in 'Schultze's Archiv,' 2nd part, 1872) has figured and described thread-cells from sponges of the genus Reniera, and also well-developed, undoubted spermatozoa. Huxley had seen spermatozoa in Tethya, Lieberkühn in Spongilla, and Haeckel appears to have seen imperfectly developed spermatozoa from various calcareous sponges, the development of which, as modifications of the flagellate cells of the entoderm, he describes in the 'Jenaische Zeitschrift,' 4th part, 1871. Haeckel, in this paper, whilst speaking of the essential identity of the ciliary and amœboid movement of protoplasm, as proved by the conversion of amœboid processes into waving cilia and *vice versâ*, witnessed by him in various cases (ova of Siphonophora, sponge-particles, Magosphœra) and by the reporter in the development of the zoosperms of the annelid Limnodrilus, places the movement of zoosperms as a third kind of protoplasmic movement, which is developed from ordinary ciliary movement just as that may have been evolved from the amœboid. The reporter would venture to question very much the justice of this distinction. The movement of the filaments of zoosperms is identical with that of cilia in every way. No more striking proof of this could be given than the movements of the aggregated zoosperms in the spermatophors of oligochætous Annelids, as described in this Journal April, 1871. The mass of agglutinated zoosperms exhibit a regular pulse-like or undulating movement of their freely hanging filaments, in every respect identical with that seen in the case of a ciliated epithelial surface.

Carter, in a recent number of the 'Annals and Mag. of Nat. His.' (September), discusses James Clark's suggestion

of the polycephalism of Spongilla. He would rather regard the individuals of Spongilla as forming a colony analogous to that of the compound Tunicata, possessing, as in that case, a common cloacal orifice. He endeavours to refute Eimer's observations on the thread-cells in sponges, by bringing forward two facts—firstly, that fragments of Cœlenterata, with abundant thread-cells, are often to be found attached to organisms with which they have no connection, and quotes a remark from Wyville Thomson to the effect that thread-cells have the power of living for some time apart from the organism to which they belong; secondly, he has observed a small hydroid polyp, parasitic in, or closely invested by, certain sponges, and he suggests that Eimer may have got hold of something of this kind.

The reporter is able to state that Dr. Eimer spent a portion of the past spring (1872) again at Capri, and repeated his observations on the occurrence of thread-cells in sponges, and appears not to have found any facts which lead him to change his already published statements. Dr. Eimer has also worked out other points in the histology of siliceous sponges, in which he has observed considerable cell-differentiation, giving rise to connective tissue and fusiform muscular tissue.

The Natural History of the Vibriones. By OSCAR GRIMM.—This paper, in the 4th part of 'Schultze's Archiv' for 1872, is of some interest, for it shows that at last the Germans are beginning to pay some attention to the question of the origin of Bacteria, concerning which so much has been written in France and England. Grimm ignores almost completely the work of other observers, referring only to the papers of Polotebnoff and Frau Joh. Lüders. He mentions the action of various reagents on Bacteria or Vibriones, as he prefers to call them, and states that he has failed to bring the electric discharge to bear upon them. He concludes that they are protoplasmic, or derivatives of protoplasm, in their chemical nature. Chains of Bacteria are formed by the fusion of previously separate individuals, not by division, according to this author. He distinguishes the molecular from the vital movements, as so many others have done and recognises two kinds of movement due to the motion of the members of a chain one on the other, and a third kind of movement, in certain large and long Bacteria, which consisted in the bending of a single individual, first to one side and then to the other. Large individuals like this Grimm saw divide spontaneously into smaller individuals. To those who doubt that Vibriones are organisms Grimm replies that they are protoplasmic, they move, they nourish

themselves, and reproduce. He is very particular in declaring that they have no vibratile cilium. No one recently has ascribed any such organ to them excepting, it appears, Joh. Lüders. Grimm finds that atmospheric air is necessary for the activity of Bacteria. He doubts Polotebnoff's assertion to the contrary. There was air in the water containing the fungus-spores from which Polotebnoff fancied he saw them develop. Without air Bacteria cease their movements, die, and decompose. As to the origin of Bacteria, Grimm believes they arise from the protoplasm of other organisms. He describes minutely their development from the protoplasm of cells in diseased cattle. Professor Gobulew confirms his assertion, saying that he has seen Bacteria develop from the blood-corpuscles of Frogs, where they appear, if the corpuscle is kept in the moist chamber, as minute granules. Grimm observes that he has no objection to urge to the supposition that minute germs, or spores of Bacteria, exist in the cells and blood-corpuscles studied by him, which develop after death into Bacteria, excepting that, if they are there, they are so minute as to be quite indistinguishable from the granules of the living protoplasm itself. Grimm appears to have used good objectives, system 9 of Hartnack, and, in many cases, the system 15 à immersion, which ought to give sound results on this question if any glass can. Grimm regards Bacteria, then, as organisms produced 'heterogenetically' from the protoplasm of other organisms. He admits that the asserted spontaneous generation of Fungi and Infusoria is devoid of any proper evidence to warrant its belief, but does not on that account think it necessary to reject the irregular origin of Bacterium or Vibrio, as made out by him. Of course, this supposition of the origin of Bacterium, from the protoplasm of other organisms, has, again and again, been advanced by various writers. It is impossible to prove the absence of minute germs, from the protoplasm of the cells of higher organisms, and equally difficult to demonstrate their presence. More observers are needed.

Occurrence of Minute Parasitic Organisms as causes of Abscess.—Von Recklinghausen ('Centralblatt,' No. 45, 1871) states that he has found colonies of minute organisms having the characters of "micrococcus," identical with those found by other observers in diphtheria, giving rise to the abscesses which occur in a whole series of infectious diseases, viz. pyæmia, puerperal fever, typhus, acute arthritis, infiltration of urine, and gangrene of the lung. They were especially abundant in the kidneys. Organisms differing somewhat from

these were found in the pyramids, in one case of scarlet fever. The interest of these observations is very great, not only in relation to pathological theories, but in connection with the asserted development of Bacteria from white blood-corpuscles (see above, Oscar Grimm's paper). Such organisms as von Recklinghausen describes might equally well be developed from minute deeply penetrating germs, or heterogenetically, as far as the evidence in this particular case goes.

A new Radiolarian from Naples, Myxobrachia Cienkowskii.—Nicolas Wagner describes in the 'Bulletin of the Imp. Acad. St. Petersburg,' vol. xvii, No. 2, a Radiolarian, which he found in the harbour of Naples, which is similar in form to the *Myxobrachia rhopalum* of Haeckel (see this Journal, January, 1871), but which differs from Haeckel's two species found off the Canaries, in some important particulars. The structure of the central capsule differs somewhat from that of Haeckel's species, which may be a mere matter of development. In place of the blood-red oil drops this species has blue ones. In place of being formed of a jelly-like mass the body of this new Myxobrachia consists of a felt of protoplasm-threads, amongst which very fine homogeneous cytods are embedded. There is no definite wall or membrane to the body, but the protoplasmic felt is denser at the periphery and there gives origin to radiant pseudopodia. Coccoliths and Coccospheres lie in the ends of the arms, as in *M. pluteus* and *M. rhopalum*, but in quite young examples they are absent. Besides Coccoliths there are present in the same protoplasm of this Myxobrachia fragments of molluscan shells, very young Spirulina, and Dentalium. Wagner suggests that the protoplasm in the ends of the arms, where these fragments and the Coccoliths occur, forms a sort of digestive apparatus, and that the nutrient products of digestion pass, by means of the ray-like threads of protoplasm, which extend from centre to periphery, to the region of the central capsule and the alveoli which surround it. A new Thalassicolla was also found which agreed with this Myxobrachia (named by Wagner after the illustrious Cienkowski) in all respects except the absence of the denser peripheral layer of protoplasm which forms the dome and the arm-like processes of Myxobrachia. The protoplasmic masses, forming the ends of the arms in Myxobrachia, may be pinched off from the rest of the animal by pressure, and they then lead an independent life, sending out pseudopodia in an active manner.

A new fresh-water Radiolarian.—Oscar Grimm describes (in 'Schultze's Archiv,' 4th part for 1872), under the name Elaster Greeffii, a fresh-water Radiolarian from bog-pools

near Nowgorod. It is very similar to a true marine Radiolarian, as, for instance, *Cyrtidosphæra reticulata*, Hkl., excepting the absence of yellow cells. It has a central capsule, and, but for this, and the great number of its radiating straight pseudopodia, might be taken for a Clathrulina detached from its pedicle. The shell is altogether similar to that of this latter form. Grimm was not able to study the specimen carefully, hence no details are given as to this central capsule. It is figured in a single drawing. When speaking of the discovery of the freshwater Radiolaria Grimm attributes all the merit to Focke and Greeff. He ought to know and to have studied Mr. Archer's various papers published in this Journal. Mr. Archer has precedence of both the German writers.

Noctiluca.—Professor Cienkowski, at the meeting of Russian naturalists at Kiew, gave the result of his further observations on the development of zoospores in this animal. We noticed at some length his paper published in 'Schultze's Archiv,' on the same subject, in our April number, 1871. Prof. Cienkowski's recent observations have been made at Odessa. He finds that the formation of the curious boss or disc from which the zoospores develop is preceded by a segmentation of the entire mass of the protoplasm of the Noctiluca into 2, 4, 8, 16, &c., parts, and that then the boss begins to grow up on the surface of the Noctiluca. He has traced fully the conversion of a normal Noctiluca into one of the disc-bearing saccules, which he described in his last paper, and which might readily be overlooked or taken for anything but Noctiluca. He was previously doubtful as to how far copulation, or the fusion of two Noctiluca, was a necessary antecedent to the production of zoospores. He now finds that it is by no means necessary, though it does frequently occur, and, as in the fusion of the zoospores of Myxomycetæ, and the copulation of Actinophrys, and others, leads to an augmentation of the mass of the protoplasm. Zoospores occur in quite small Noctilucæ which certainly could not be the product of the fusion of two individuals. In the zoospores, in the neighbourhood of the attachment of the cilium (see woodcuts in former abstract, 1871), a thin long process is to be observed, which Cienkowski regards as the rudimentary 'whip' or 'vibraculum' of the adult, and we thus have in the zoospores all the characteristic parts of the mature Noctiluca. Sometimes the zoospores develop very rapidly whilst still in the disc, and their protoplasm becomes differentiated into nucleus and radiating threads. Cienkowski considers that the zoospores of Noctiluca decide the

systematic position which must be assigned to this organism. It seems to him that they are animals of large dimensions belonging to the division of the Flagellata.

A Hydroid Parasite from the Eggs of the Sterlet (Acipenser ruthenus).—Professor Owsjannikoff, in the course of investigations on the embryology of the Sterlet, came across a very anomalous parasite living within the thick egg-shell. He figures it in the first part of the 17th volume of the 'Bulletin de l'Acad. Imp. des Sciences de St. Petersburg.' It is not fixed, and lives for some time when liberated from the egg in fresh water. It has somewhat the appearance of a double or quadruple Hydra, there being generally four heads of tentacles to each specimen sessile on a short conical body. Each head has six tentacles. No thread-cells were detected. The animal multiplies by transverse fission, an individual with four heads splitting transversely into two with two heads each of which in turn develop the complement of four. The animal appeared to take in nourishment whilst living free in water containing confervæ, &c. The account now given of this very strange organism is very incomplete, but Prof. Owsjannikoff has no doubt that he will be able shortly to give a more detailed notice of it. It is obviously a very immature form. The mode of its entrance into the eggs is altogether a paradox.

Rotatoria.—At the meeting of Russian naturalists, held this year at Kiew, Dr. Salensky described the development of the summer eggs of *Brachionus urceolaris*. Two balls result from the first cleavage, one of which then divides further and surrounds the other. The enclosed mass then divides. The trochal discs begin as an elevation surrounding a depression of the outer cells, which becomes the mouth. The foot develops from the hinder part of this ridge. The nerve ganglion develops from the outer layer of cells. The inner cells give rise to the alimentary canal, to the lateral glands, and (the author says) to the ovary. The rectum, like the œsophagus is formed by a pushing in of the outer layer. A middle layer of cells is said to arise (how is not stated) which give rise to the muscles. Salensky observes that the formation of the trochal disc and of the foot takes place exactly as does that of the velum and foot in the Mollusca, as studied by him in the case of Calyptræa.

Prof. Carl Semper describes (in 'Siebold's u. Kölliker's Zeitschrift,' 3rd part, 1872) a remarkable spherical Rotifer, which he terms *Trochosphæra æquatorialis*. It occurs in freshwater ditches, in the rice-fields of Zamboanga, in the Philippine Islands.

Leech or Fluke.—In the same journal Prof. Semper has some remarks on the crustacean genus Leucifer, and on the curious tentacle-bearing worm *Temnocephala chilensis* parasitic on Thelphusa, and other freshwater Crustacea, usually classed with the leeches, but which Prof. Semper would place with the Trematoda.

Development of the simple Ascidians.—The investigation of the development of these animals, which has become so intensely interesting since Kowalewsky's demonstration of its identity in essentials, and even in many details, with that of Amphioxus, and hence of Vertebrata generally, is still being carried on by German and Russian embryologists. Professor Küpffer, of Kiel, describes, in 'Schultze's Archiv,' part iii, 1872, the development of *Molgula microsiphonica*, n. sp., and the nervous system of the larva of *Ascidia mentula*. There have been some curiously contradictory statements as to whether Molgula develops through a larval form or directly, and Prof. Kupffer clears up the point in dispute between MM. Hancock and Lacaze Duthiers. The observations on the larva of *A. mentula* are very interesting. The "spinal cord" of the larva is shown to possess an axial cellular substance and cortical fibrillar substances; also spinal nerves are described passing from it to the muscles, as Huxley and others have described in Appendicularia. The structure of the eye appears to be peculiar, inasmuch as it presents a transition from the invertebrate to the vertebrate type of eye, with a retina developing from the cerebral vesicle.

Elias Metschnikoff, in 'K. u. S. Zeitschrift,' 3rd part, 1872, criticises Kowalewsky as to some minor points of interpretation relating to the development of the nervous system, and declares that that naturalist in 1866 had overlooked the true nervous system, and "that I am the discoverer of the part in question." We know that Metschnikoff is indebted to Kowalewsky for considerable assistance in carrying on work on the Mediterranean fauna (*e.g.* the material for his memoir on the development of a Nemertean from a Pylidium-larva), and it seems a pity that these two eminent Russian embryologists should not live at peace with one another—content to excite the envy and criticism of German naturalists. It will be remembered that Metschnikoff had a very unfortunate dispute as to the proprietorship of a "discovery" with Prof. Leuckart, when he was his pupil at Giessen. Metschnikoff denies that the central nervous system in *Ph. mammilaris* is derived entirely from the outer layer of the embryo. He maintains that cells of the inner layer also take part in its formation, a very curious and in-

consistent mode of origin, if it really is so. He objects to Küpffer's observations on the matter, as not furnishing data for comparison, since he worked upon *Phallusia canina*, the ova and embryo of which are not so transparent as those of *Ph. mammillaris*. He maintains that this species must be used for the observation of Ascidian development, or one equally transparent. Ganin and Dönitz he very wisely admonishes to study suitable material before critcising Kowalewsky's statements. Metschnikoff writes from Funchal, in Madeira.

A very excellent and full account (illustrated by three plates) of Kowalewsky's, Küpffer's, and other researches on the development of the Ascidians, is given by M. Girard, in the second part of Prof. Lacaze Duthiers' new 'Archives de Zoologie.' We recommend this to readers.

The Otocysts or Auditory Capsules of the Mollusca (Gasteropoda), by Prof. Henry de Lacaze Duthiers.—The first and second parts of his 'Archives de Zoologie' contain this elaborate and beautifully illustrated memoir by the illustrious French zoologist. Its publication was delayed, together with the whole Archiv, during the war, hence it is only now that the author submits the details and drawings establishing the fact which he announced as long ago as 1868, and which we noticed at that time. In the interval Lacaze Duthiers' researches have been confirmed by Leydig, who has published on the subject in 'Schultze's Archiv' (see this Journal for 1871, p. 421). We need hardly remind the reader that what Prof. Lacaze Duthiers then announced was, that the otolithic capsules of Gasteropodous molluscs (for which he now proposes the convenient designation of otocysts) do *not* receive their nerve from the pedal ganglion, as commonly supposed by such men as himself, Leydig, Huxley, and others, but that the auditory nerve descends to the otocyst from the cephalic ganglion. Thus, as in Heteropods and Nudibranchs, the cephalic ganglion is the centre of the sensory organs. In the present memoir the fullest details are given as to a variety of genera of Gasteropods—Cyclostoma, Pileopsis, Paludina, Ancylus, Neritina, Helix, Planorbis, Limax, Patella, &c. More than thirty species have been studied. Where the object of a memoir is to bring forward evidence to establish a proposition of a startling character, it is useless to give any abstracts of the statements it contains. Comparative anatomists must examine the beautiful drawings of M. Lacaze Duthiers for themselves. We may just observe that the evidence admits of no kind of doubt, and all that has been said about the connection of the pedal ganglion and auditory function is simply exploded. We have

no hint from the author as to whether the connection in Lamellibranchs is really with the pedal ganglion or not, nor does he touch on the case of the Cephalopods. One thing is to be remarked about the auditory nerve. It is a hollow tube, differing much in appearance from the other nerves of the Gasteropods. It was this tube which Adolf Schmidt thought formed a communication between the exterior and the cavity of the otocyst. The reporter (E. R. Lankester) is able to state definitely, from researches carried on at Naples last winter, that the otolithic sac in Nudibranchs develops from cells of the outer layer of the embryo, but never has any communication with the exterior. In cephalopods, on the contrary, he repeatedly observed its development by a pushing in of the outer layer, the orifice of the cavity so formed eventually closing in, and its neck remaining as the curious little ciliated appendage of the otocyst described by Kölliker in Loligo.

Natural History of Dero obtusa.—In Professor Lacaze Duthiers' admirable 'Archives de Zoologie Expérimentale,' M. Edmond Perrier commences an account of this interesting Naidoid worm. In the part already published he describes the anatomy and structure of the annelid during its period of scissiparity; in a second paper he proposes to deal with its sexually mature condition; and in a third he intends to describe the development. The respiratory apparatus, with its four digit-like processes, situated at the anal extremity, is well figured and described; but it is from the succeeding parts of M. Perrier's memoir that we expect to derive the most information, since, with the exception of a preliminary notice by Mr. Ray Lankester, in the 'Annals of Nat. History,' 1870, no account of the generative organs of a Nais has yet been published.

The Layers of the Blastoderm in the Hen's Egg.—Professor Peremeschko stated, at the meeting of Russian naturalists, that though he, with Remak, recognised three layers, yet he did not consider that the middle (mesoblast) developed from the inner (hypoblast), but that it arose independently from peculiar formative elements. These last, on account of their deficiency in nucleus, belong to the category of cytods (Haeckel), exhibit active movements, and appear to take their origin from the white yolk. At the first they collect in numbers on the floor of the segmentation cavity, and then pass into the space between the outer and inner layers. The three layers, therefore, arise independently of one another, and can be readily separated, except at those spots where the outer and middle layers become at an early period fused.

PROCEEDINGS OF SOCIETIES.

Dublin Microscopical Club,

April 18th, 1872.

Rev. E. O'Meara brought forward a new Navicula to be named *N. dicurvata*, of which description and figure would hereafter appear.

Dr. Macalister showed a good mounted specimen of his new *Adenopleura compressa*, the subject of a communication in a previous number of this Journal.

Dr. John Barker exhibited an adaptation by him of a one-inch objective to his small microscope as a "searcher," as proposed by Dr. Royston Pigott, which performed in the present instance very well, giving large amplifying power with great clearness. Dr. Barker's ultimate aim was, however, its adaptation to a binocular microscope, as he conceived two low power objectives (say one-inch) could be brought to bear on the object and the amplifying power attained by the usė of the searcher, one in each body.

Dr. Moore showed further specimens of the same little alga (brought forward at the February meeting) from the tanks in Botanic Garden, which continued flourishing as before, these specimens seeming still to sustain the views propounded thereupon on the previous occasion.

Dr. McNab showed sections made through the flattened disc of the glandular hairs of *Ampelopsis Veitchii.*

Dr. Richardson exhibited some exceedingly beautiful slides elegantly mounted by Mr. C. Baker of the anchors and scales of Synapta and of the spicules of *Hyalonema mirabile*, or glass-rope sponge, the latter showing the cruciform, biclavate, spiral-cylindrical and multihamate spicules. Dr. Richardson also showed some nice mountings, by Dr. Battersby of various eyes of flies, forming very handsome objects.

Mr. Archer showed a minute alga, very probably the same thing as the *Cylindrocapsa nuda*, Reinsch, in his work 'Die Algenflora des mittleren Theiles von Franken' (pp. 66, 67, t. vi, f. ii). This was certainly a form he had not before met with; the chief differences in the present examples from Prof. Reinsch's plant consisted in the hyaline investment, wrapping the cells around more closely than that author depicts it, and in the contents forming a continuous parietal layer, with a central clear space, not equally diffused, as appears in Reinsch's' figure.

Mr. Archer showed the seemingly rare little animalcule *Dasydytes goniathrix* (Gosse). This he had seen on only a few previous occasions, but had not before an opportunity to exhibit it at a Club meeting. A casual observer might possibly look at the present examples and suppose the form common, confounding it with its relatives in the genus Chætonotus. If time had permitted, Mr. Archer would have sought out and drawn attention

to some of the more common Chætonotus forms for comparison, for some of the gatherings taken on the same occasion presented *Chætonotus larus*, Müll. (common), *Ch. maximus*, Ehr. (rather common), *Ch. gracilis*, Gosse (rather rare); *Taphrocampa annulata* (Gosse) also occurred, but this appears to be very rare, at least quite as rare as Dasydytes.

Mr. Archer showed (thanks to Prof. Thiselton Dyer) sections made from a sample of the "Australian Caochouc," an account of which had just appeared, detailing all that is known of this puzzling substance by Prof. Dyer, in the 'Journal of Botany.'

Mr. Archer brought down to show the Club a copy of a most valuable memoir from Sweden by P. M. Lundell, for which much esteemed gift he had now most heartily to thank not only the author but also the Hon. N. Jocelyn for so courteously becoming the careful medium of its transmission—this memoir entitled 'De Desmidiaceis, quæ in Suecia inventæ sunt, Observationes criticæ.' This fine and copious contribution to our knowledge of the Desmidieæ, though published in 1871 (so slow is the process of interchange of publications between distant scientific societies) had not before met Mr. Archer's observation, and indeed had only just, through the author's goodness, reached his hands. Here was a great mass of the most careful and extraordinarily exact observations most accurately elucidated. Mr. Archer had from meeting to meeting brought forward several "new" forms obtained from Connemara, and had shown a few drawings of the most striking, but strange to say here they were or nearly all depicted by Lundell, and not only the very finest of them but several others not less interesting but only less striking, which Mr. Archer had not ventured to take up the time of the meetings by endeavouring to find and exhibit, as, being (some of them) scarce, it would be too large a draught on general patience—several of these too found a place in Lundell's work. It was almost as if that author had made a journey to the same Connemara sites, and found, of course, the same things! There were still a few (the best, indeed, abstracted!) which as yet have not presented themselves in their most rich localities to the keen eyes of the Scandinavian workers, but it would take no little time thoroughly to analyse such a large *résumé* of exact observation. It is at least highly satisfactory to find observers to take the pains to examine and *know* the distinctions which hold good amongst these forms, rather than to "cut the gordian knot," as some would do, simply by adopting the *easier* plan of ignoring those differences which *exist*, all our discussion thereupon notwithstanding. When he had time to compare his own forms more fully and thoroughly to work up this excellent memoir, perhaps Mr. Archer would have occasion to draw the Club's attention to some points bearing thereon on some future occasion.

May 22nd, 1872.

Dr. J. Barker showed several of the most "difficult" diatoms

under his dark ground illumination (such as *Navicula rhomboides*, &c.), the whole of the striæ being brought out with extremely clear precision.

Mr. Archer exhibited examples of three very "closely allied" and much resembling minute forms of Cosmarium, two of these in the conjugated condition, pointing out Ralf's figure of the zygospore of the third (*Cosmarium tinctum*), for the purpose of showing how amongst Desmidieæ, the mature form of certain species may so closely resemble each other, but yet possess extremely different zygospores; no doubt, indeed, the converse is not rarely true, that is, that certain species may offer very tangible and even strong differences *inter se*, yet possess zygospores mutually very closely resembling each other. One of the forms now in question was *Cosmarium tinctum* (Ralf's), of which he could not find a conjugated specimen on the present occasion, *Cosmarium tenue* (ejus), 'Quart. Journ. Micr. Sci.,' N. S., vol. viii, p. 293), and the third a new species; of these the first has a subquadrate, or polyhedral smooth light-coloured zygospore, the second a large globular brown-coloured (when mature) zygospore, the third an irregularly figured variously lobed zygospore, the lobes surmounted by generally a pair of short tapering subacute spine-like processes. The last had thus a zygospore resembling that of *Cosmarium lobatosporum* (Arch., in 'Quart. Journ. Micro. Sci.,' vol. xv, N. S., p. 171), but then the mature form is quite dissimilar. It will not be assumed that of the three related species now exhibited the mature forms were not appreciably distinct, for, when the eye gets accustomed to them, their differences are in reality quite observable; still they might be easily passed over the one for the other, in the unconjugated state. Neither *Cosmarium tenue* nor the above-referred-to new one appears to occur in Sweden, but, as to be expected, Lundell includes *C. tinctum* in his enumeration.

Rev. E. O'Meara exhibited from Capt. Chimmo's prolific Diatomaceous gathering from Sulu, a further new Navicula to be hereafter named *N. vertebrata*.

Dr. Frazer showed a fine Photograph of scale of *Degeeria domestica* executed by Colonel Woodward of the United States (with a Powell's $\frac{1}{16}$), and forwarded by that gentleman.

Dr. Richardson exhibited some further mountings by Mr. Baker of London, one of the spicules of *Hyalonema mirabile* (not as on the last night of meeting on separate slides, but) showing the three forms geometrically arranged, in such a way that at each corner of the figure there is a multihamate spicule, in the centre of the cylindro-cruciform spicules, with densely spiculate shafts, as well as having the shafts smooth and the ends spiculate. Dr. Richardson also showed *Plagiogramma elongatum* and *Actinocyclus Ralfsii*, both being exquisite mountings of Mr. Baker's. Dr. Richardson showed, lastly, a transverse section of the spinal cord of the cat, surrounded by transverse sections of its membranes; the specimen was taken from a piece of the cord hardened according to Mr. Lockhart Clarke's method and subsequently stained

with a strong carmine solution and then clarified in oil of clove, and finally mounted in Klein's Dammar fluid. In this section, as well as indeed in all taken from this cord, the arrangement of the gray matter and the central canal were very clearly demonstrated.

Professor McNab gave some details of his examination of the "vegetable hair" (brought forward by Dr. Frazer at last night of meeting) now much used for the manufacture of "chignons," and forming a beautiful glossy "hair," capable of being dyed any (fashionable) colour; Dr. McNab, however, had arrived at the conclusion that this was produced from the "New Zealand flax," the fibres being used in the rough, the finer portions not being eliminated.

Mr. Archer showed, for the first time detected in this country, *Œdogonium Areschongii* (Wittrock), showing both forms of fructification nicely developed; he also showed *Œdogonium acrosporum* (de Bary) with both forms of fructification now found in two or three situations in Ireland, but this very singular form is always seemingly very scanty in its occurrence.

Mr. Archer showed examples of the plant he had named *Dictyosphærium constrictum* ('Quart. Journ. Mic. Soc.,' vol. xiv (n. s.), p. 127), though he thought it possible this might really be found to possess a closer relationship to *Cosmocladium* (Bréb.) than to *Dictyosphærium* (Näg.), though characterised on a single in place of a double stipes; this is at least a most marked and constant form though rare; the mode of vegetative growth of the cells is, like that of a desmid, by interposition of a two new halves between the older and a new stipes appearing for each new cell, thus causing a bifurcation of the stipes, but an opportunity to observe this seldom presents itself.

Mr. Archer showed the conjugated state of a minute diatom which Mr. O'Meara identified as *Cocconema cymbiforme* for the first time seemingly seen in that condition, but which, however, presented no novel feature; here were two new frustules twice the linear dimensions of the empty parent valves, the whole involved in a common mucous envelope.

27th June, 1872.

Dr. Moore showed *Peziza æruginosa* found on decayed oak; he remarked that wood so infected, on account of its shining bluish-green colour, was used for inlaying for ornamental purposes at Tunbridge Wells.

Rev. E. O'Meara presented from the Sulu material, already so rich in diatomaceous novelties, a further new Navicula to be named, in compliment to Dr. Moore, *Navicula Mooreana,* of which due description would subsequently appear.

Mr. Archer exhibited examples of the *Cylindrocystis* detected by him some years ago at Upper Lough Bay ('Quart. Journ. Mic. Soc.,' vol. xiv n. s., p. 60), and never yet found elsewhere, the present examples from the same site showing now the conjugated state, for which, though he had repeatedly searched, he had not hitherto been successful enough to meet with. There

was, however, not anything very special, the globular zygospore is formed free between the empty parent cells not as in *C. Brébissonii*, combined with them; the same reddish-purple colour which marks the unconjugated examples, is found in the zygospore, and is due, not as Mr. Archer had previously supposed, to this colour imbuing the cell wall, but to its belonging to the protoplasmic contents, through which a longitudinal string of chlorophyll contents passed, and it is to the predominance of this colour above the green that the reddish-purple colour in the mass in the pool is due. The application of potash or acid at once and suddenly deprives the protoplasmic contents of this colour, which is curious to watch under the microscope. A central nucleus is a prominent feature, but it is not quickly or strikingly made to acquire a bright colour by the application of the carmine solution, as happens so notably in most Desmidieæ. There can be no doubt that this seemingly singularly local form is a quite distinct one, of which Mr. Archer hoped ere long to publish an appropriate description.

Dr. Barker showed *Polyphemus pediculus* and young, the latter even still more quaint-looking objects than the mature animal, which had been taken by himself and Mr. A. Andrews in Lough Bay. This striking entomostracan had now been taken, on each occasion plentifully, in west and east of Ireland.

Dr. McNab exhibited an instructive preparation showing cambium layer in a section from the lime, beautifully stained by carmine fluid, rendering it very readily examined.

Mr. Keit showed a new *Peziza* from the Botanic Gardens, as well in its entirety as the asci and spores under the microscope, and an excellent drawing of the details; the spores are broadly elliptic and bluntly pointed (or elliptico-fusiform) and distinctly and finely warted; the form he hoped to make the subject of future examination and research with a view to publication.

Mr. Archer presented examples of *Vasicola ciliata* (Tatem), a seemingly rare and withal very pretty infusorian; of *Pamphagus mutabilis* (Bailey), of *Gomphosphæria aponina* (Kütz), the latter for the purpose of showing the appearance of the cells during the progress of self-division, in illustration of this incidental allusion, thereto, in his paper just published bearing on the chroococcaceous genus *Tetrapedia* (Reinsch).

EAST KENT NATURAL HISTORY SOCIETY.

President, the Rev. John Mitchinson, D.C.L., &c., Oxon.; Honorary Secretary, George Gulliver, F.R.S., &c.

July 4th, 1872.—*Food of Naïdina.*—Colonel Horsley exhibited some small and lively species of naïd worms, from a freshwater pool in the neighbourhood. They were seen under the microscope feeding greedily on *Volvox globator*, and numbers of this minute plant then appeared inside and distinctly through the transparent bodies of the animals.

New Fossil Fish.—Mr. James Reid laid on the table and gave a short and very interesting account of a fossil fish which he had obtained two or three years ago from the Gault, near Folkstone. Dr. Günther, having examined the specimen, stated that it is quite new, and belongs to the Clupeoidei, and he has named it *Thrissopater Salmoneus;* a very valuable addition to our fossil fauna.

Ammocœtes branchialis.—Mr. George Gulliver (of Pembroke College, Oxford) showed under the microscope sections of this larval fish, made by hardening in chromic acid and staining with carmine. Though the eyes do not appear externally, perfect eyes and their chambers and crystalline lens were seen in the sections; the auditory sac and its coarsely ciliated epithelium were shown, as were also the ovaries, well developed in this immature fish, with numerous ova presenting the germinal vesicle and spot; and the infolding of the inner coats of the gut, like an intestine within an intestine, was well displayed. All these points are easily seen under the microscope by this method of preparation.

Eggs of Argas reflexus and Ixodes Dugesii.—Some females of these Acarina having been confined in boxes kept in Mr. Gulliver's library, and at Mr. Fullagar's, during May and June, continued lively without food up to the beginning of July, about which time they were found to have laid many eggs. Of *Argas* these were spherical, generally about $\frac{1}{54}$th of an inch in diameter, of a dull grayish colour, and slightly rough on the surface; a few of them were of a suboval shape. Thus, these eggs differ from those of *Ixodes Dugesii* in size and shape, for of this last species the eggs are regularly oval, about $\frac{1}{40}$th of an inch long and $\frac{1}{60}$th broad, very smooth and of a shining chocolate colour; in both species the egg-shells are composed of chitine.

July 18*th*, 1872.—*Excursion.*—This took place in the neighbourhood, and the party was hospitably entertained by the Vice-President of the Society, Colonel Horsley, at his residence, St. Stephen's Lodge, near Canterbury.

Raphides of Onagraceæ.—The botanical specimens brought in from the excursion, with several other contributions by Mrs. Dean, were the following:—Epilobium parviflorum, Torilis anthriscus, Lathyrus pratensis, Scrophularia aquatica, Ranunculus scleratus, Eryngium maritimum, Hyoscyamus niger, Salsola kali, Trifolium fragiferum, Lactuca saligna, Artemesia maritima, Cynoglossum officinale, Carex vulpina, and Poa pratensis. This miscellaneous and random collection affording a good opportunity for trials of the value of the raphidian character, these were carefully made. The result was that in no plant were any raphides found except in the *Epilobium,* in which they were, as they regularly are in the order to which it belongs, very plain and abundant. And thus in our flora the diagnosis was maintained, as formerly shown, of Onagraceæ—*Calycifloral exogens abounding in raphides.* Yet this short diagnosis, so easily demonstrable and eminently natural, has not yet found its place in our books of systematic botany.

Auditory Capsule of Mollusca.—In the little bivalve *Cyclas cornea,* so common in our ditches, the auditory vesicle and its

vibrating otolith are so very beautiful and easily found that it must become a favorite microscopic object. Mr. Fullagar, after two or three trials, by tearing asunder with needles portions near the base of the creature's foot, succeeded perfectly in showing the vesicle and its oscillating otolith, much to the admiration of the meeting. Figures of the auditory vesicles of several molluscs are given in the 'Journal of Anatomy,' vol. iv.

August 1st, 1872.—*Skeleton of Lamna cornubica.*—The Hon. Sec. gave a detailed account of the preparation and completion of this remarkable skeleton at the College of Surgeons, of which full reports have appeared in the 'Kentish Gazette,' August 6th, 'Land and Water,' August 17th, 1872, and several other periodicals. The skeleton is seven feet nine inches in length, and, owing to the judicious preparation, has lost only four inches in drying. There are no ribs. The vertebræ number 152, of which sixty belong to the tail, and these last turn upwards along the superior border of the caudal fin, while in some other Selachians, as *Scyllium*, the caudal vertebræ end in a straight line with the trunk. The claspers are bony, each composed of three pieces, the terminal piece being a curious spine, as if for intromission.

Progression of Arachnida in opposition to gravity.—Referring to observations at the meeting of July 6th, the walking of Ixodes on the under and polished side of glass was shown to be due to the effect of atmospheric pressure on the elastic pedal caruncles of the creature, and that this is also the case with the great Tiger Spider of Ceylon had been clearly proved by Dr. Davy, in his 'Physiological Researches,' p. 336, 8vo, Lond., 1863.

August 15th, 1872.—*Ichneumonidæ.*—Mr. Fullagar exhibited living specimens from his vivarium of these hymenopterous insects, hatched out of the chrysalis of the Red Admiral butterfly, and read a paper on their habits and economy.

Palate of the Cyprinoids.—This soft structure, so well known in the Carps, has commonly been regarded as a gland analogous to the pancreas. Mr. George Gulliver, having made preparations of this so-called palate, by hardening it in chromic acid and then staining fine sections with carmine, exhibited them under the microscope at the meeting. The tissue of the part presented a large proportion of transversely striped muscular fibres; and the mucous surface was beset by large papillæ, so as to present rather the character of a tactile organ than of a gland.

Neuronaia Lampetræ.—Referring to the notices in the 'Proceedings of the Zoological Society,' Dec. 6th, 1870, and 'Quart. Journ. Mic. Science,' Jan., 1872, concerning this entozoon, preserved specimens were shown under the microscope to be entirely devoid of the spines near the mouth and on the surface of the body which characterise the allied *Neuronaia Monroii* of Goodsir. When magnified, *Neuronaia Lampetræ* somewhat resembles Yarrell's figures, of the natural size, of *Tristoma coccineum*, which occurs on the skin and branchiæ of the sun-fish.

Eggs and newly hatched Broods of Ixodes Dugesii and Argas reflexus.—Referring to the description of these eggs at the meet-

ing on the 4th July, Mr. George Gulliver now exhibited the newly hatched young of both these species. Swarms of the young broods were found on the 1st of August free from the eggs (the hatching continued up to the last day of observation, on the 15th) and running actively about, trying to escape from their prisons. These young of the two species were miniatures of their parents; only, as already known of some other immature Acarina, they had six legs, and these so crowded that no room appears, before a moult, for the wanting fourth pair, except posteriorly. Besides, in Argas the body of the young was fringed, especially at its hind part, with hyaline hairs; and these little creatures are so transparent that the urinary sacs near the anus were seen to be filled with the granules of guanine described at the meeting on June 6th, 1872, and reported in the 'Quart. Journ. Mic. Science' of the following month. Thus, the dart-like mandibles, with recurved teeth and the articulated palps, were much produced in the young of both species, especially of Argas. *Ixodes* is so very prolific that one female confined in a pill-box laid no less than 143 eggs, all of which, except six, were hatched. Having thus discovered the time and manner of breeding, and how easily these creatures may be bred for observation in confinement, we may already perceive some practical applications. Thus, the usual attempts of flockmasters to relieve their suffering sheep by picking off the parasites and throwing them on the ground is simply sowing the vermin broadcast, for all these bloated *Ixodes* are pregnant females, ready to lay their eggs to be hatched spontaneously. The ravages of this arachnid on sheep and pheasants have been dreadful this season in the neighbourhood of Canterbury.

September 5th, 1872.—*Excursion to Whitstable.*—Colonel Horsley, Mr. Sibert Saunders, and Mr. Fullagar, collected several Campanularidæ, Tubularidæ, Annelida, and Ascidiæ, and exhibited them in different marine aquariums, giving at the same time very instructive demonstrations of the various living animals under the microscope. Mr. Sheppard and Mr. Fullagar exhibited and illustrated the habits and economy of Pagurus in living specimens. Mrs. Dean collected and named numerous phænogamous plants, among which was Hippophaë rhamnoides; and Mrs. Fairbrass arranged a bouquet of wild flowers so as to prove how effectively they may be used for graceful decoration.

September 19th, 1872.—*Blood-disks of Gadidæ.*—The meeting was chiefly occupied in the examination of plants lately collected near Canterbury by Mrs. Dean; in microscopic demonstrations of the wings of Ephemerinæ and diurnal Lepidoptera by Colonel Horsley and Mr. Fullagar; and in the determination of some species of fishes collected a few days since at Hastings by Mr. George Gulliver. Of the fishes, it was shown that the red blood-corpuscles of the little *Motella* are as large as those of other and big members of the Gadidæ; and thus that the relation of size between the species and its blood-disks, long since proved by the Hon. Sec. in mammals and birds, is not maintained in fishes, nor is it in reptiles; and the facts are of much physiological significance.

INDEX TO JOURNAL.

VOL. XII, NEW SERIES.

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DESCRIPTION OF PLATES I, II, III, IV,

Illustrating Dr. Klein's paper on the Peripheral Distribution of Non-medullated Nerve-Fibres.

All these preparations are prepared with gold chloride. The mode of preparation is to be found in the text.

PLATE I.

Fig.

1.—Preparation of the rabbit's cornea. Magnifying power, Hartnack's eyepiece No. 3, objective No. 10 immersion.
  a. A larger nerve-fibre of the subepithelial plexus.
  b. Small nerve-fibres of the subepithelial network.
  c. Smallest fibrillæ of the same network.

2.—Nictitating membrane of the frog. Magnifying power, Hartnack's eyepiece No. 3, objective No. 5.
  a. Larger non-medullated nerve-fibres (nerve-fibres of the second order).
  b. Finer ones (nerve-fibres of the third order).
  c. Pigment-cells.
  d. A gland.

3.—Nictitating membrane. Magnifying power, Hartnack's eyepiece No 3, objective No. 8.
  Distribution of the finer nerves under the epithelium of the posterior surface.
  a. Nerve-fibres of the second order.
  b. Nerve-fibres of the third order.
  c. Finest nerve-fibrillæ of the fourth order.

4.—A capillary vessel of the nictitating membrane. Magnifying power, Hartnack's eyepiece No. 3, objective No. 8.
  a. The capillary vessel with blood-corpuscles.
  b and *c*. Non-medullated nerve-fibres.

PLATE II.

5.—Nictitating membrane. Magnifying power, Hartnack's eyepiece No. 3, objective No. 8.
  a. Capillary vessel.
  b. Blood-corpuscles.
  c and *d*. Non-medullated nerve-fibres.

6.—A gland from the nictitating membrane. Magnifying power, Hartnack's eyepiece No. 3, objective No. 8.
  a. The gland.
  b, *c*, and *d*. Non-medullated nerve-fibres.

7.—Nictitating membrane. Magnifying power Hartnack's eyepiece No. 3, objective No. 9, immersion.
  a. Branched cells. *b*. Nucleus.

PLATE II (*continued*).

FIG.

8.—Nictitating membrane. Magnifying power, Hartnack's eyepiece No. 3, objective No. 10, immersion.

a. Pigment-cells in the superficial layer of the anterior surface.
b. Nucleus.
c. Varicosities of the process.
d. Larger pigment-granules.

PLATE III.

9.—Nictitating membrane. Magnifying power, Hartnack's eyepiece No. 4, objective No. 10, immersion.

a. Pigment-cells of the middle layer of the nictitating membrane.
b. Nucleus. *c.* Nucleolus.
d. Processes.
e. An ordinary branched cell.

10.—Nictitating membrane. Magnifying power, Hartnack's eyepiece No. 4, objective No. 8.

a and *b.* Subepithelial non-medullated nerve-fibres.
c. Finest nerve-fibres between the deepest epithelial cells.
d. The deepest epithelial cells.

14.—A capillary vessel of the mesentery of the frog.

a. The vessel with blood-corpuscles.
b and *c.* Non-medullated nerve-fibres.

PLATE IV.

11.—Mesentery of the frog. Magnifying power, Hartnack's eyepiece No. 3, objective No. 8.

a. A larger trunk of medullated nerve-fibres.
b. A single medullated nerve-fibre.
c and *d.* Non-medullated nerve-fibres.
e. An element belonging to the membrane.
f. An intercalated nucleus of a fine nerve-fibre.
g. A capillary vessel.

12.—A, an artery; B, a vein of the mesentery of the frog, showing the distribution of the fine non-medullated nerve-fibres in the adventitia. Magnifying power, Hartnack's eyepiece No. 3, objective No. 7.

13.—Small vessels of the mesentery of the frog. Magnifying power, Hartnack's eyepiece No. 9, objective No. 7.

a. The vessel with blood-corpuscles.
b, c, and *d.* Non-medullated nerve-fibres.

E

F. Klein, del.

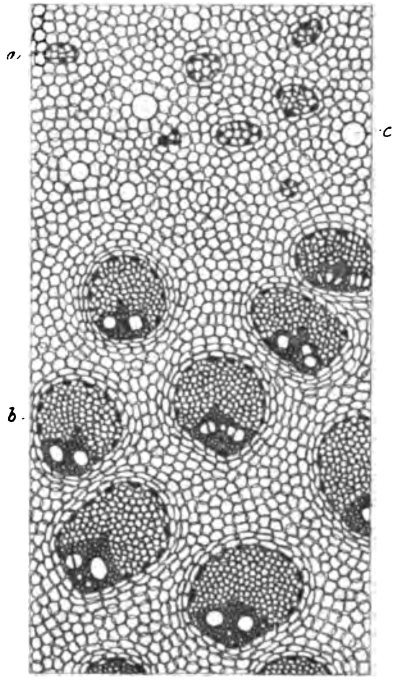
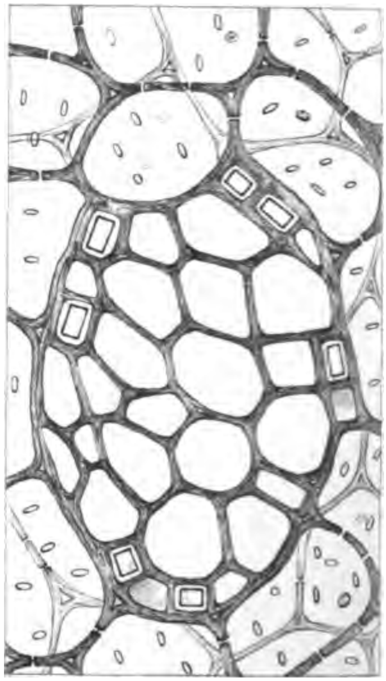


Fig. 1.



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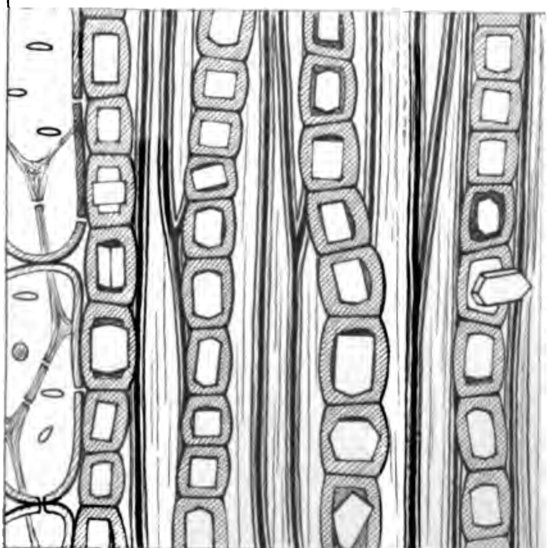

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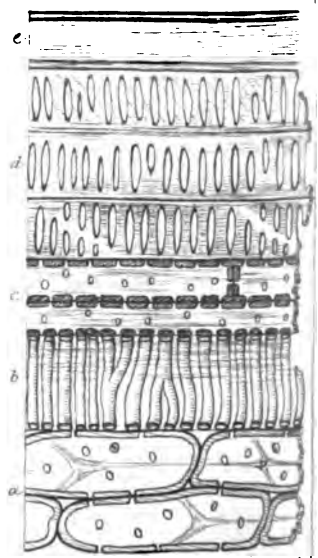

Fig. 4.

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JOURNAL OF MICROSCOPICAL SCIENCE.

PLATE V,

Illustrating Professor Thiselton Dyer's paper on the Structure of the Stem of the Screw Pine.

Fig.

1.—Transverse section of a portion of stem of *Pandanus utilis*, Bory. × 14. The small chequered areas in the upper part of the figure represent sections of the external evascular bundles. The larger areas in the lower part are the central fibro-vascular bundles. The dark cells bordering each contain the crystals. The clear round spaces in upper part are enlarged parenchymatous cells originally containing raphides.

2.—Transverse section of one of the evascular fibrous bundles × 450. The prismatic crystals are seen *in situ* in the marginal cells. The cell-walls of the surrounding parenchyma are porous.

3.—Longitudinal section tangential to a fibro-vascular bundle × 450. The strings of crystal-bearing cells are seen to lie externally to the elongated liber cells. The large cells on the left belong to the general parenchyma.

4.—Longitudinal section (somewhat diagrammatic) of the internal portion of a fibro-vascular bundle × 450. It represents in ascending order from below upwards the following parts :—*first*, porous cells of the general parenchyma compressed laterally; *secondly*, a spiral vessel; *thirdly*, wood-cells; *fourthly*, scalariform vessel with three of its sides in view; and *finally*, a liber-cell.

Fig. 1.

J. Drummond, del. J. Erxleben, lith.

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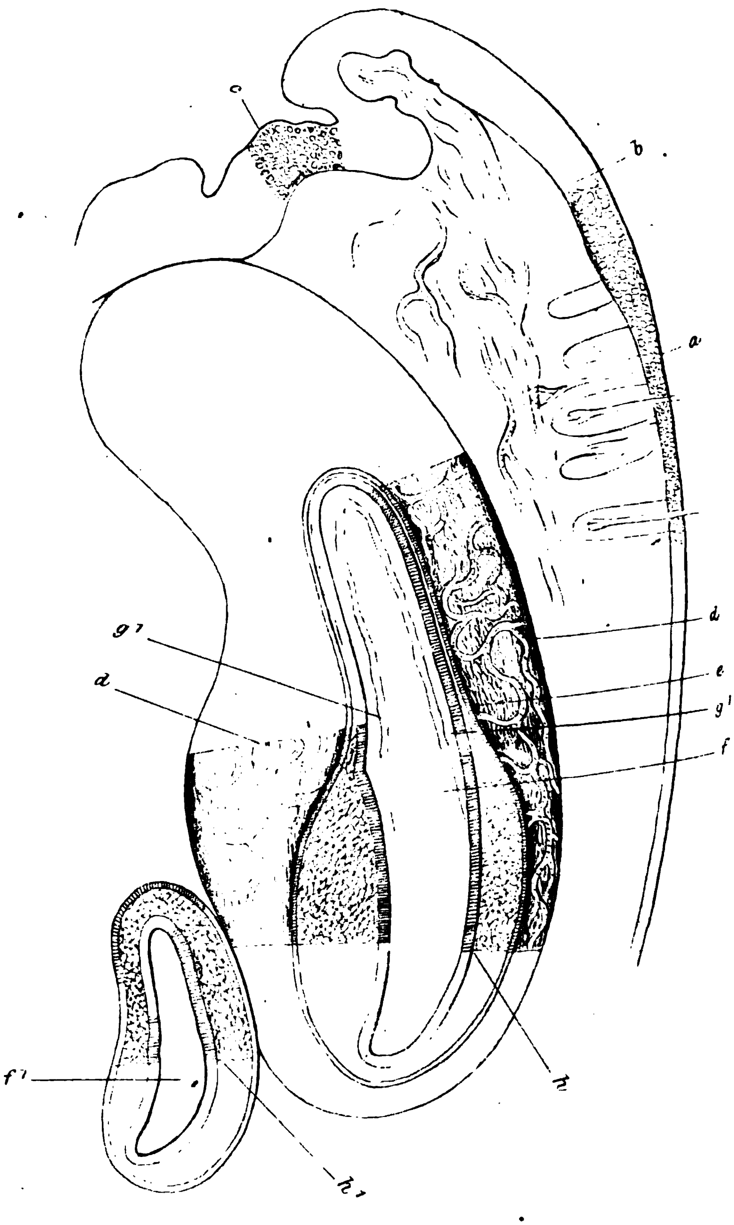
Fig. 2.



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EXPLANATION OF PLATES VI & VII.

Illustrating Dr. Rolleston's paper on the Development of the Enamel in the Teeth of Mammals, as illustrated by the various Stages of Growth demonstrable in the Evolution of the Fourth Molar of a young Elephant, *Elephas indicus*, and of the Incisor Teeth in the Fœtal Calf, *Bos taurus*.

DESCRIPTION OF PLATE VI.

FIG. 1. Portion of left half of lower jaw of young Elephant, *Elephas indicus*, showing the fourth molar in course of development, and a part of the third molar, some of the denticles of which were in use, and some still within their socket. The teeth are seen from the inner side, the bony wall having been removed, and the capsule of the posterior tooth having been reflected. The dentinal pulp is coloured blue, the dentine yellow; the vessels are represented as seen when filled with a red injection. From a preparation made by Mr. C. Robertson.

a. Part of inner side of lower jaw interposed between the posterior denticles of the third and the anterior denticles of the fourth molar.

b^1. Part of third molar tooth. Its anterior denticles were in use; some of its more posteriorly placed were just about to cut the gum, and the most posteriorly placed were still within the bony socket.

b^2. Processes of dentinal pulp, dividing to supply the denticles of third molar.

c. Sac of tooth reflected and fastened out over the jaw above and below.

d^1, d^2, d^3. Capsular processes surrounding denticles. On the internal or dentinal aspect of the most anteriorly placed of these (d^1), a granular deposit is observable. This deposit corresponds to a deposit (g^1), of similar appearance, which encrusts the upper part of the cap of dentine (f^1), and it represents the proximal ends of the enamel columns which have broken away from the more perfectly calcified segments which constitute the (enamel) deposit (g^1), on f^1.

e^1, e^2, e^3, e^4, e^5. Processes of the dentinal pulp passing up to form the successive denticles of which the composite molar is made up.

e^6. A number of processes homologous with those similarly lettered, but differing from them in having as yet formed no cap of dentine upon their exterior surface.

f^1, f^2, f^3, f^4, f^5. Caps of dentine which have been formed by the processes of dentinal pulp (e^1, e^2, e^3, e^4, e^5). Upon the three most anteriorly placed of these caps of dentine (f^1, f^2, f^3), a deposit of enamel has taken place, the area occupied by which diminishes in length from before backwards, in correspondence with the lessening evolution of the denticles. Upon the two most posteriorly placed (f^4, f^5), of the dentinal caps no deposition of enamel has as yet taken place.

g^1, g^2, g^3. Level to which the deposit of enamel has reached upon the dentinal caps (f^1, f^2, f^3), respectively.

DESCRIPTION OF PLATE VII.

FIG. 2. Section of anterior portion of lower jaw of fœtal calf, *Bos taurus*, taken in an antero-posterior or sagittal direction; showing the enamel organs of two teeth, one larger and the other smaller, *in situ*. The section has passed through the lateral portion of each tooth; and as the incisors in this species have their crowns laterally expanded, whilst their

fangs are compressed from side to side, the central stem of the dentinal pulp is not seen in this section, and the enamel organ passes entirely round its lateral expansion. The dentinal pulp itself is not represented in either of the two teeth; two contour-lines, bounding the apical half of the space which it occupied in the larger of the two teeth, show the extent to which the deposition of enamel and dentine severally had proceeded upon it. In the smaller of the two teeth the deposition of enamel has not commenced, and the enamel organ has as yet suffered no diminution of its "spongy," or "gelatinous," or "stellate" tissue. This drawing being semi-diagrammatic, segments only of the histological elements making up the epithelium of the gum, the epidermis of the lip, the tooth-sac, and the enamel organs, have been given; the contour-lines prolonged in each case from the external boundaries of these segments, appearing to indicate sufficiently the relations held in nature by the several structures.

a. Anterior surface of lip.

b. Epidermis of lip.

c. Epithelium of gum.

d. Tooth-sac, which at this stage in the development of the tooth, and before it receives any support from the bony structures in the jaw, is clearly marked off by layers of condensed cellular tissue from the strata of *cutis vera*, which are interposed between it and the external epidermis. The loose spongy central portions of the tooth-sac bear some resemblance, when viewed with the unassisted eye, to the similarly placed stellate element of the enamel organ; they differ from it, however, by being vascular, and even highly vascular; whilst they differ from the *cutis vera*, not merely by their greater looseness of texture and their greater vascularity, but also, as seen in the figure, by the absence of glands, of hair-bulbs, and of muscular tissue.

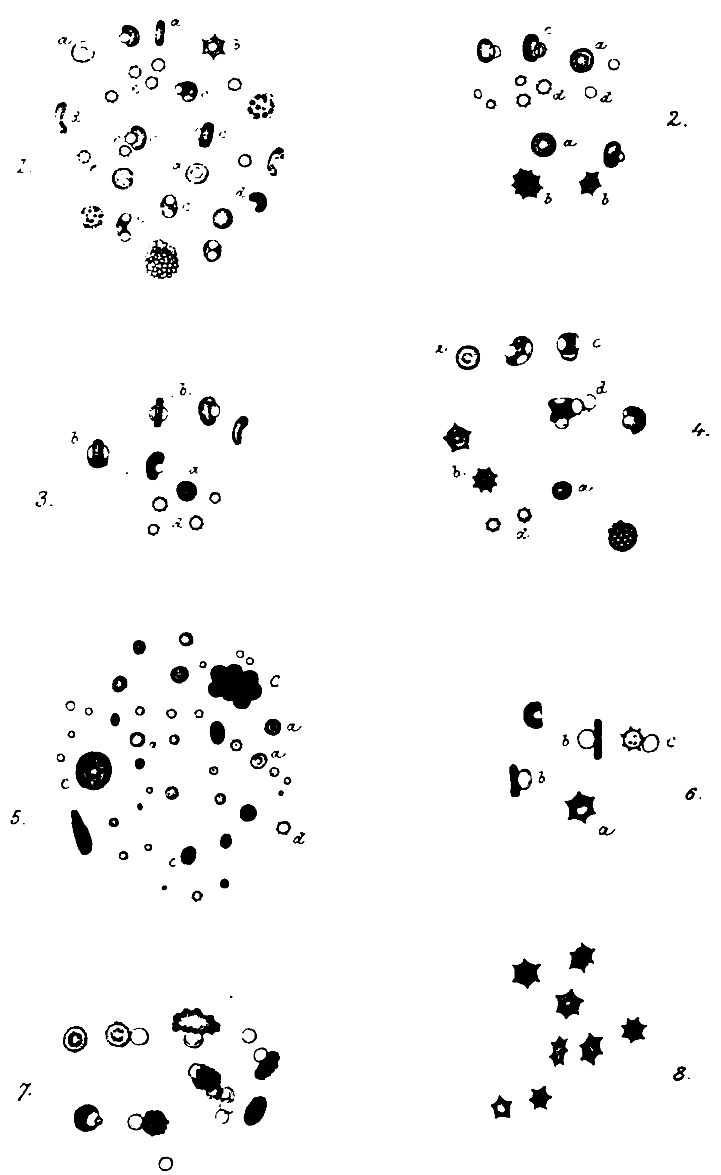
e. Enamel organ. From the point to which the line *e* is drawn, downwards, the enamel organ of the larger tooth is seen to possess all the three structures; viz., the inner epithelium, the stellate or spongy tissue, and the outer epithelium, which the enamel organ of the smaller tooth (h^1) still possesses. Above the point to which the line *e* is drawn, the stellate tissue has disappeared, and the two layers of the enamel organ's epithelium have come into apposition. Thus the epithelial cells of the inner layer, which produce the enamel prisms, or "fibres," come into closer relation with the blood-vessels of the tooth capsule, whence alone, in the absence of vessels in the enamel organ, they can provide themselves with the requisite mineral matter.

f. Space in the larger tooth occupied by the laterally projecting portion of the spoon-shaped dentinal pulp.

f^1. Corresponding space in the smaller tooth: in neither tooth did the central stem of dentine come into view in this section.

g^1. Contour-line indicating the extent to which the deposition of enamel has proceeded in the larger tooth. This line corresponds to the similarly lettered granular deposit in fig. 1. Internally to this line a second line is seen describing a similar contour, but reaching considerably further down. It indicates the extent to which the cap of dentine reaches downwards upon the exterior of the pulp; this extent being considerably greater (as is seen also in fig. 1) than that attained to by the deposit of enamel at this period of development.

h and h^1. Line of junction, in the larger and smaller tooth respectively, of the stellate tissue of the enamel organ to its inner layer of epithelium. In both enamel organs the outer layer of epithelium is drawn as more nearly columnar than it is in nature.



J. Braxton Hicks M.D. del^t

M^c Farlane & Erskine Lith^{rs} Edin^r

EXPLANATION OF PLATE VIII,

Illustrating Dr. J. Braxton Hicks's Observations on Pathological Changes in the Red Blood-corpuscle.

Fig.

1.—From ovarian cyst.
a, a, a. Red blood-corpuscles, nearly natural.
b. Ditto, stellate form.
c, c, c. Red corpuscle, separating into "zoid" and "œcoid." J. Brücke.
d, d, d. "Zoid" after separation.
e, e, e. "Œcoid" after separation; diameter $\frac{1}{10000}$ inch.

2.—Red corpuscles after remaining in a serous vesicle in the living body.
a, a. Red corpuscle, but slightly altered.
b, b. Ditto, stellate form.
c, c, c. Ditto, separating into œcoid and zoid.
d, d. "Œcoids" after separation.

3.—Red corpuscles after remaining in serum from a dead body.
a. Red corpuscle, but slightly altered.
b, b. Ditto, separating into "œcoid" and "zoid."
c. Zoid after escape of œcoid.
d, d. Œcoid separate.

4.—From ovarian cyst.
a, a. Red corpuscles, natural.
b, b. Ditto, stellate.
c, c. Ditto, separating into "œcoid," and "zoid."
d, d. Œcoid free; diameter $\frac{1}{4000}$ inch.

5.—Retained menses.
a, a. Red corpuscles.
c, c, c. Masses of red colouring matter of variable but all of larger size than the red corpuscle, of plastic consistence and darker.
d, d. "Œcoids" free. The separating state was not observable.

6.—Red corpuscles shortly after having been placed in fluid from a hydrocele.
a. Stellate form.
b, b. Separating into "zoid" and "œcoid."
c, c. Œcoid" free.

7.—Same as fig. 6, but after remaining in the fluid twelve hours. The form of the stroma of the corpuscle is very irreguiar. The separation of the œcoid is very well marked. Diameter of the "œcoids" $\frac{1}{4000}$ inch.

8.—Red corpuscle in contact with mucous membrane. The stellate form was the only change observable.

EXPLANATION OF PLATE IX,

Illustrating Dr. J. Mitchell Bruce's paper on the Structure of Tendon.

Fig.

1.—Tendon of tail of a young rat. Chloride of gold preparation. Magnifying power, Hartnack's eyepiece No. 2, objective No. 8.

2.—Tendon of the same. Nitrate of silver preparation. Magnifying power about 250.

a. Endothelium of the tendon.
b. Subendothelial *Saftkanälchen.*

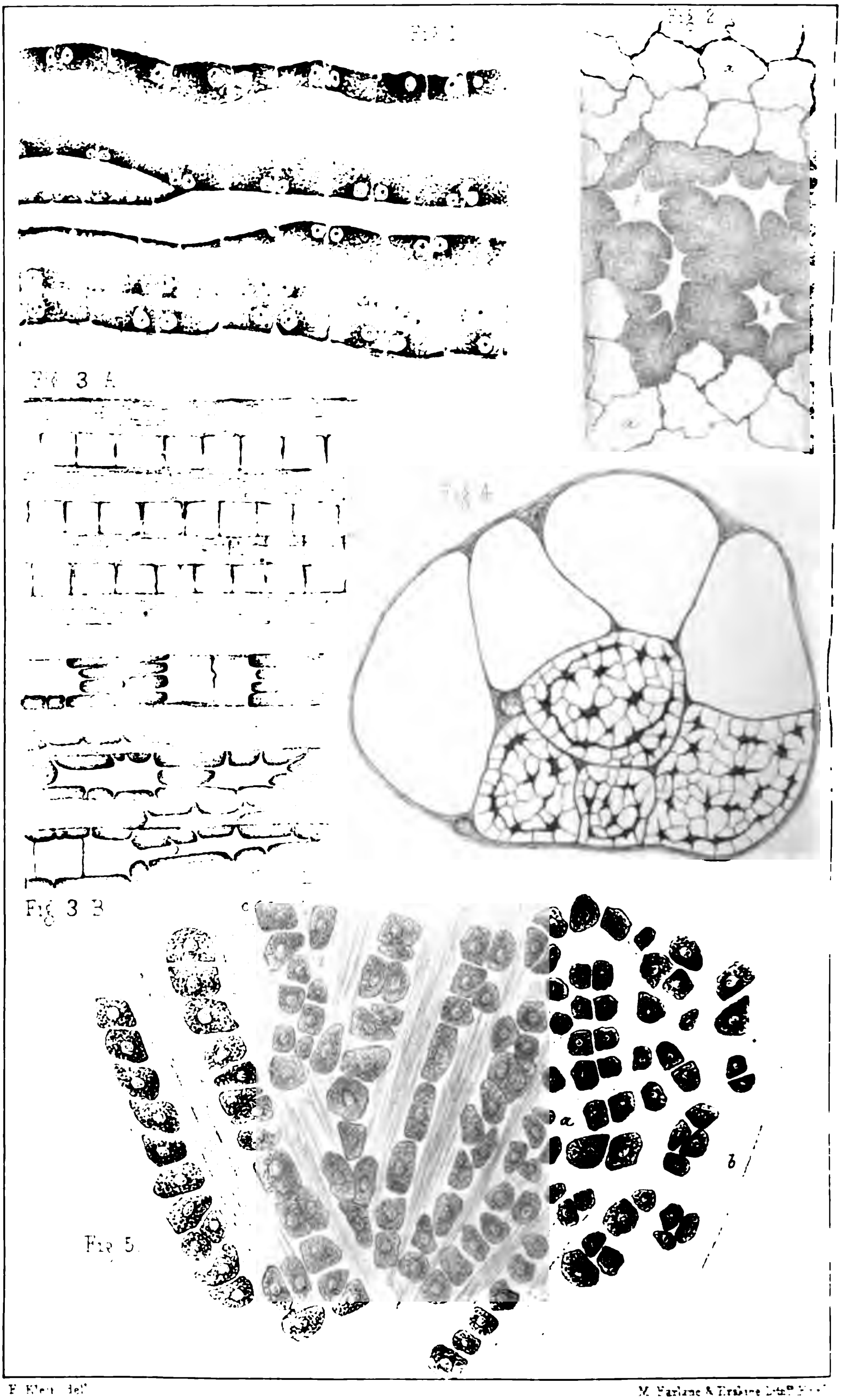
3A.—Tendon of the same, prepared with nitrate of silver.

3B.—Tendon of the tail of an adult rat, prepared with nitrate of silver.

4.—Transverse section of the tendons of the tail of a young rabbit. Chloride of gold preparation. Magnifying power about 250.

5.—Transformation of intervertebral substance into cartilage. Chloride of gold preparation.

E Klei



F. Klein del.	M. Farlane & Erskine Lith. Edin.

DESCRIPTION OF PLATE X,

Illustrating Dr. E. Klein's paper on the Peripheral Distribution of Non-medullated Nerve-fibres.

Fig.

1.—Preparation of the tongue of the frog. Magnifying power, Hartnack's eyepiece No. 3, objective No. 7.

A. A small artery.
a. Capillary.
b. Cells of the intermuscular tissue.
c. Coarser non-medullated nerve-fibres.
d. Finer ones.

2.—From the same portion of the tongue. Magnifying power, Hartnack's eyepiece No. 2, objective No. 7.

a. A capillary vessel, near A, in a small vein passing.
b. Medullated nerve-fibres.
c. Non-medullated nerve-fibres.
d. Finer non-medullated nerve-fibres.

3.—From the same portion of the tongue. Magnifying power, Hartnack's eyepiece No. 3, objective No. 8.

a. Capillary vessel.
b. Coarser non-medullated nerve-fibres.
c and *d*. Finer ones.

All three figures from preparations prepared with chloride of gold.

Fresh preparations treated with very dilute acetic acid.

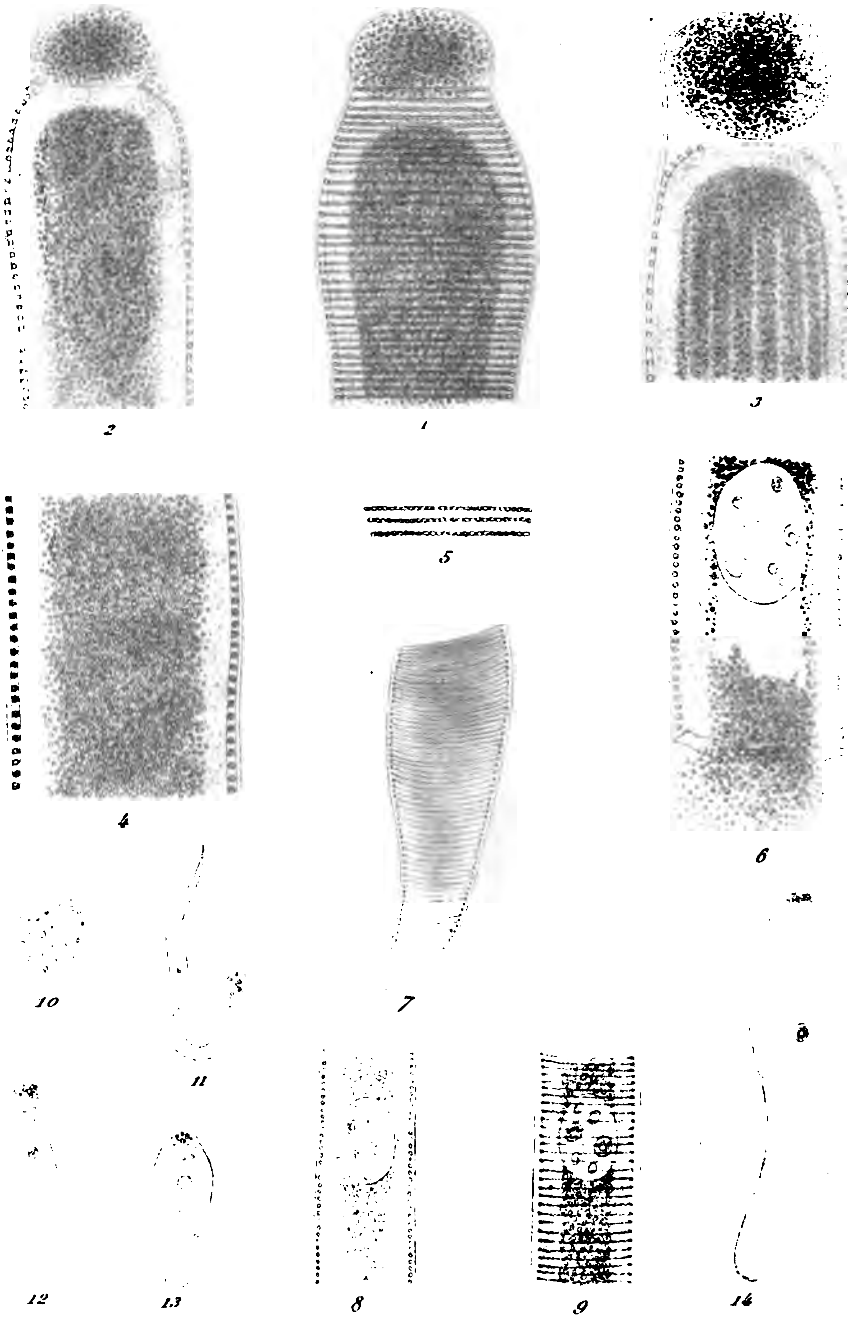
4 A.—Ciliated duct seen in profile. Magnifying power, Hartnack's eyepiece No. 2, objective 8.

a. Ciliated epithelium.
b. Deeper epithelial cells.
c. Medullated nerve-fibres.
d. Non-medullated ones.
e. Plexus of the same amongst the deeper epithelial cells.
f. A subepithelial nerve-cell.

4 B.—The same plexus seen from the surface. Magnifying power, Hartnack's eyepiece No. 3, objective No. 10 immersion.

a. Medullated nerve-fibres.
b. Non-medullated ones.
c. Plexus of the latter ones.
d. Deeper epithelial cells.

Mém. Savans étr. T. XXXV. Pl. XI.



E. V. Van Beneden ad nat. del.

Lith. G. Severeyns Brux.

Gregarina gigantea.

EXPLANATION OF PLATE XI,

Illustrating Professor Van Beneden's paper on Researches on the Structure of the Gregarinæ.

Fig. 1.—Shows the anterior portion of the body of an adult Gregarina, seen on the surface, and showing the transverse striations, the different tunics or layers, and the anterior chamber, with the partition of separation between the two chambers. (Obj. 9 à immersion with ocular 3 of Hartnack.)

Fig. 2.—Anterior part of the body of another individual as it presents itself in optical section. (Obj. 8 oc. 3 of Hartnack.) Remark that the optical sections of the fibrils on a level with the partition of separation between the two chambers are very numerous.

Fig. 3.—Same part of the body of another individual remarkable for a greater development of the anterior chamber, a greater thickness in the partition, and a different arrangement of the transverse fibrils near the partition. The longitudinal striation is also to be seen appearing on the surface of the medullary column; it depends on a particular state of contraction of the cortical layer. The transversal fibrils have been represented in optical sections. (Obj. 10 à immersion and oc. 1 of Hartnack.)

Fig. 4.—Optical section of the body, to show the different layers and the distinct character of the granules of each of them. Under the cuticle is seen the muscular tunic composed of a fundamental homogeneous transparent substance and of transverse fibrils seen in this plate in optical section. (Obj. 10 à immersion and ocular 3 of Hartnack.)

Fig. 5.—Three isolated transverse fibrils. It is seen that they are composed of refracting corpuscles quite close to one another. (Obj. 10 à immersion of Hartnack.)

Fig. 6.—Part of the body near the nucleus. The body having been torn, the medullary column has partly run off, and a cylindroid cavity has been developed between the nucleus and the receding medullary column. The cortical substance remains in its place.

Fig. 7.—Posterior part of the body of a Gregarina which had rolled itself into a ball surrounded with a cyst of connective tissue in the coats of the rectum. It had still kept its form and all its characters of structure.

Figs. 8 and 9.—These figures show highly magnified the part of the body of a young Gregarina near the nucleus; figure 8 shows the optical section, 9 the surface of the body.

Fig. 10.—Monerian condition of the Gregarina.

Figs. 12 and 13.—The nucleus appears; the body has changed form and has considerably enlarged. All vermicular movement has stopped at this phase of the evolution.

Fig. 14.—Ulterior phase of development.

EXPLANATION OF PLATE XII,

Illustrating Dr. Pavesi's paper on the Circulation of the Blood in Pyrosoma, especially as observed in the Embryo.

All the figures except the last have been drawn from nature; only those organs important for giving the relations of parts are indicated. Letters have throughout the same signification, that is to say—*ar*, vessel of the cord which communicates with the heart; *av*, vascular canal of the rudiments of the embryos; *be*, mouth of the embryos: *bn*, mouth of the nurse; *br*, branchiæ; *c*, heart of the nurse; *c'*, heart of the embryo; *c''*, heart of an adult Ascidian; *cbr*, blood-vessels of the branchiæ; *cv*, vascular cord; *e*, compound embryos; *e'*, budded embryos; *est*, endostyle; *g*, ganglion; *n*, nurse; *p*, pericardium; *sp*, peripheral sinus of the nurse; *ss*, blood-sinus of the adult embryos; *tg*, gemmiferous tube or peduncle of an adult Ascidian; *v*, vessel of the cord which opens into the peripheral sinus of the nurse; *vn*, food-yolk of the nurse.

Fig.

1.—Nurse with the band of four embryos, running along which is seen the vascular canal; the vitellus of the nurse is obvious near one extremity of the embryos. × 50.

2.—First appearance of the heart of the nurse. × 50.

3.—Nurse with its heart in its pericardium; the vascular cord and its continuation to the interior of the embryos are seen. × 50.

4.—Nurse with the heart communicating with the peripheral sinus and with one of the vessels of the cord; the other vessel opens directly into the sinus; the neural surface of the first and fourth embryos can be seen, and the vascular cord which is attached beneath their ganglion; between them is seen the second embryo, from the endostylic surface, and the cord concealed behind. × 50.

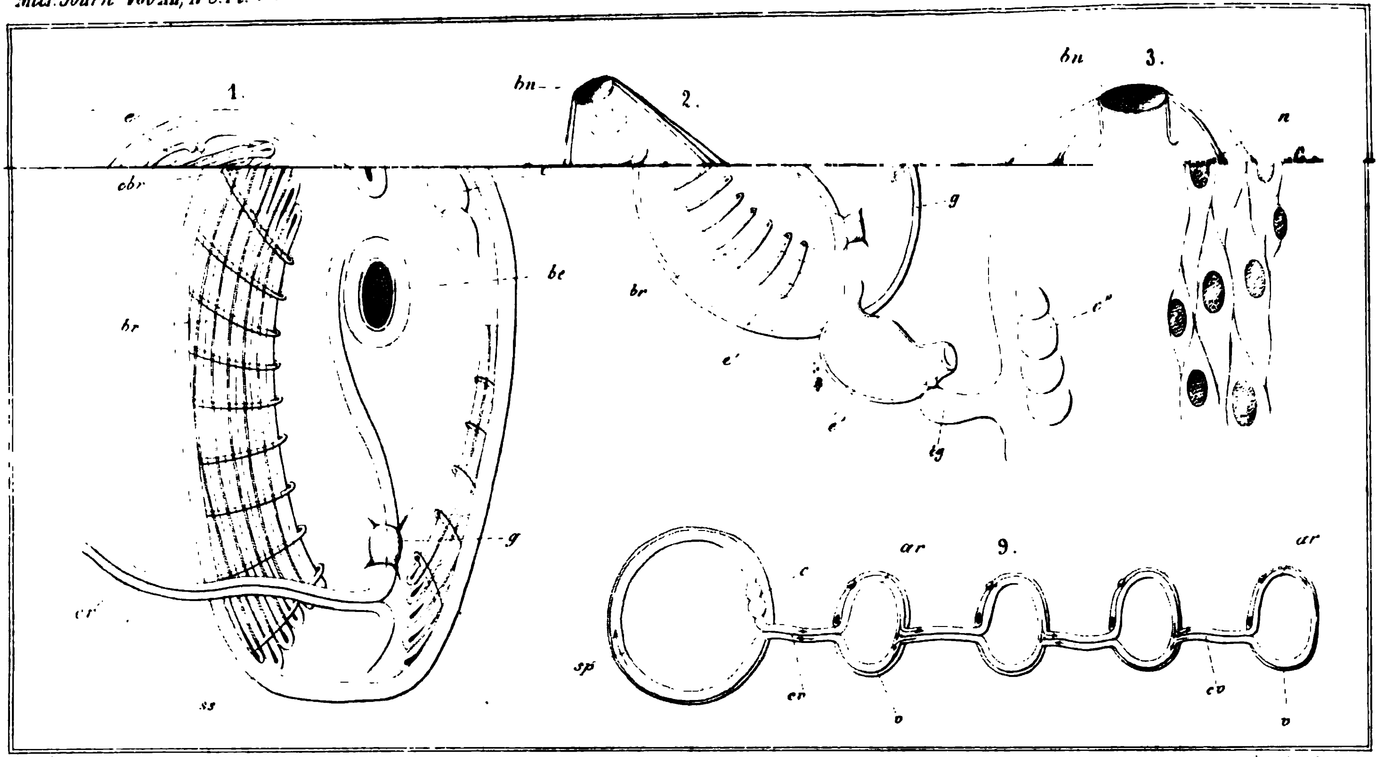
5.—The hearts of the embryos appear for the first time and coexist with that of the nurse; it is very much reduced. × 50.

6.—One of the developed embryos when the nurse has disappeared; the vascular cord is atropied; the space between the two tunics is a blood-sinus, in which the heart is seen; the branchiæ present their canals traversed by blood, and communicating with the sinus; a part of the branchiæ is not represented, in order to expose the heart. × 50.

7.—Budded embryos, in the most developed of which is seen the vessel which passes from the ganglion towards the endostyle; a part of the mother Ascidian with the gemmiferous tube and the heart is represented. × 50.

8.—Fibro-cellular tissue of the external tunic of the vessels of the embryos. × 700.

9.—Diagram to show more clearly the course of the vessels in the series of compound embryos; the arrows indicate the direction of the blood in a given moment. In the figure the vessel *ar* represents the artery, and *v* the vein; when the current is reversed, *v* becomes the artery and *ar* the vein.



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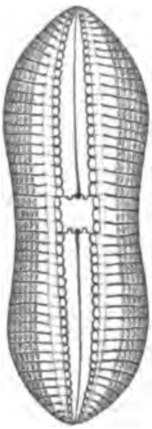

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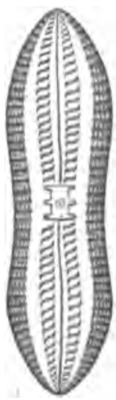

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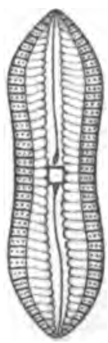

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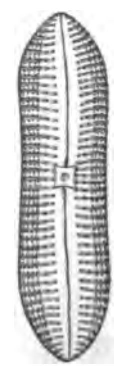

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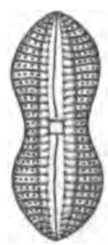

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DESCRIPTION OF PLATE XIII,

Illustrating the Rev. E. O'Meara's paper on Some Peculiar Forms of Navicula from the Sulu Archipelago.

Fig. 1.—*Navicula Chimmoana.*
„ 2.—*Navicula Suluensis.*
„ 3.—*Navicula spiralis.*
„ 4.—*Navicula unipunctata.*
„ 5.—*Navicula bipunctata.*
„ 6.—*Navicula plutonia.*

× 400.

DESCRIPTION OF PLATE XIV,

Figs. 1—4,

Illustrating Prof. Thiselton Dyer's Note on the Imbedding of Crystals in the Walls of Plant-cells.

(After Pfitzer.)

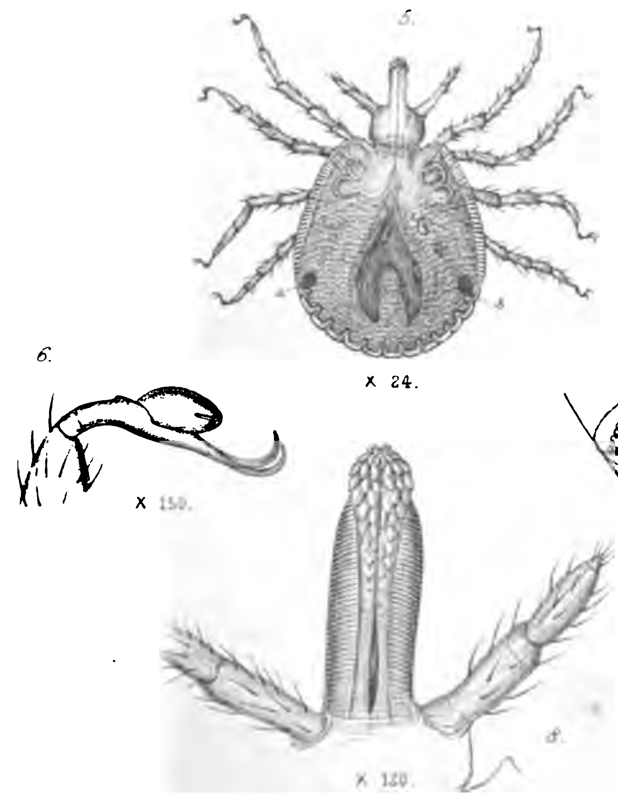
Fig.

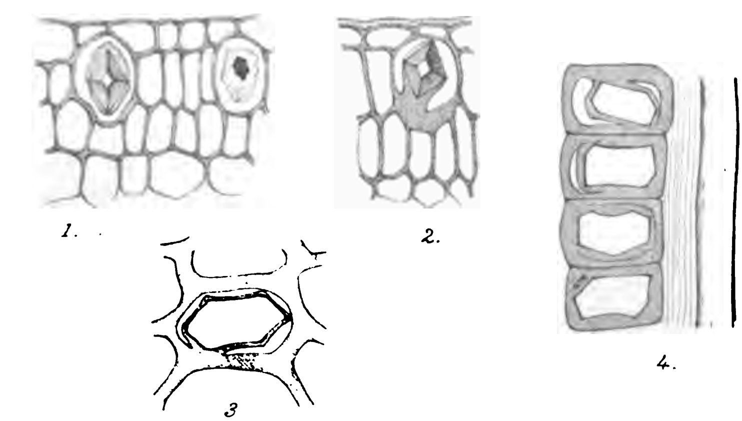
1.—Section through the upper epidermis and the underlying layers of cells from a young leaf of *Citrus vulgaris*, Risso. × 400.

2.—A similar section through an adult leaf. × 400.

3.—Section through an old crystal-bearing cell from *Citrus vulgaris*, Risso, showing the cavity left after the crystal has been dissolved by hydrochloric acid. × 400.

4.—Crystal-bearing cells adjoining bast bundles of *Populus italica*, Mnch., macerated, and the crystals dissolved out by hydrochloric acid. × 400.





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DESCRIPTION OF PLATE XIV,

Figs. 5—8,

Illustrating Professor Macalister's paper on a Description of a New Species of Ixodes.

Fig. 5.—*Adenopleura compressa*. *a*. Lateral gland. *b*. Orifice of its duct.

„ 6.—Double claw of same.

„ 7.—Lateral gland × 150.

„ 8.—Mouth and head appendages.

DESCRIPTION OF PLATES XV, XVI,

Illustrating Dr. Ord's paper on "Molecular Coalescence," and on the Influence Exercised by Colloids upon the Forms of Inorganic Matter.

PLATE XV.

Forms observed in thirteen sections of the gelatin plug used in the first experiment.

Fig. 1.—First slide, from calcic end.
a. Large tables of oxalate of calcium seen sideways; *b*, the same, flat; *c*, smaller tablets; *d*, compound tablets.

„ 2.—*a*. Homogeneous dumb-bell formed within large tablet; *b*, *c*, *d*, *e*, dumb-bells and allied spheroidal homogeneous bodies.

„ 3. Various forms of coalescence-bodies, showing their relation to tablets. (Slide 2.)

„ 4.—Tablets and spherules of a new series; the spherules (*a*, *b*, and *c*) growing to large rounded, fibrous rhombohedra, composed of calcic carbonate; the tablets growing, further on, to "wheat-sheaves." (Slides 3 to 7.)

„ 5.—Formation of "wheatsheaves" from the thick tablets. (Slides 8 to 13.)

„ 6.—Flattening and feathering of octohedra. (Slide 13.)

PLATE XVI.

„ 1.—Forms assumed by calcic oxalate in gelatin, acetic acid being present in excess.

„ 2.—Oxalic acid in excess of calcium salt. Series constructive of flattened octahedron.

„ 3.—Oxalic acid in excess. Series of dumb-bells from calcic end, where they are homogeneous and rounded, to oxalic end, where they are crystalline ("wheatsheaves").

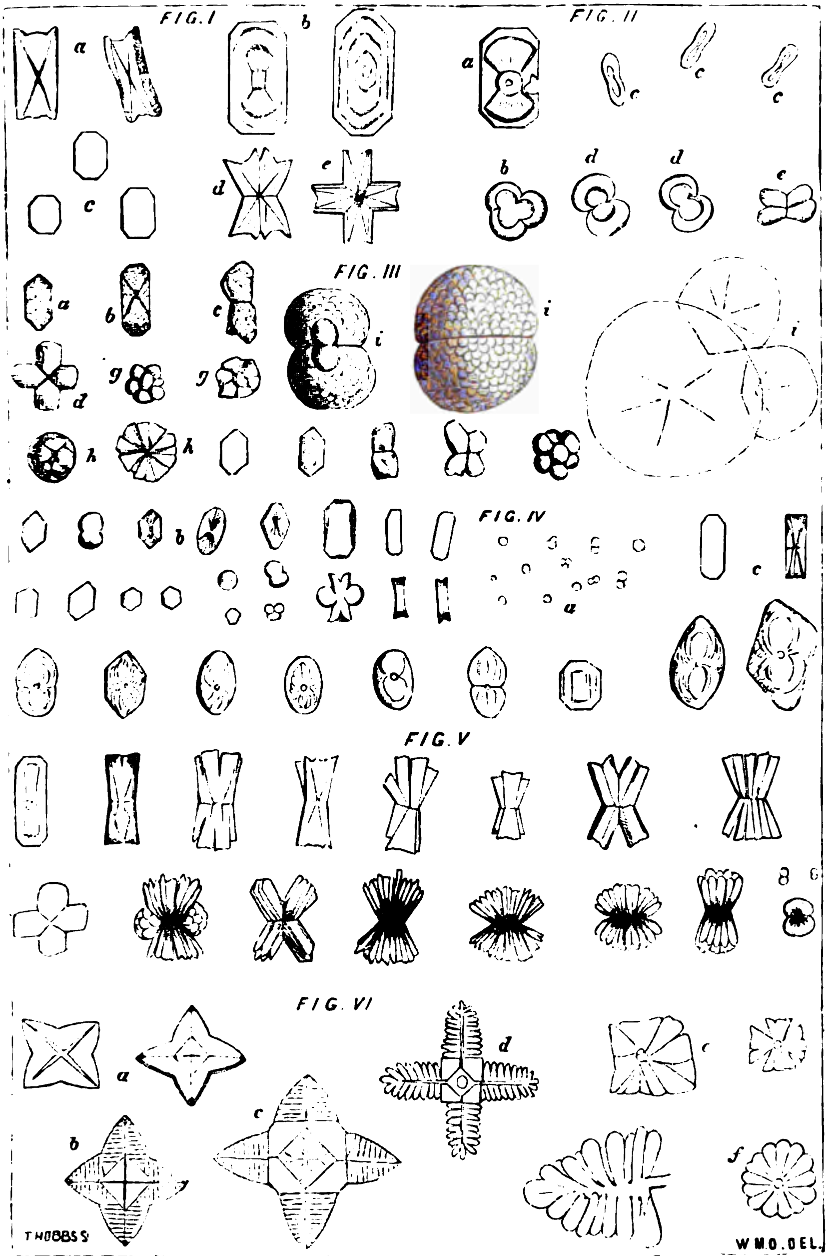
„ 4.—Oxalic acid in excess. Octohedra passing into much facetted tablets.

„ 5.—Thinning of tablets on calcic side of plug.

„ 6.—Oxalate of ammonium and calcic chloride. Form of "wheatsheaf" observed in oxalic region of plug. Note, that I have, since this was drawn, observed similar forms twice in urine.

„ 7.—Comparison of forms observed in magnetised plug with those formed at the same time, all other conditions being perfectly equal, in non-magnetised plug. The large tablet-shaped bodies were formed in the magnetic arc.

„ 8.—Oxalate of copper, as deposited in gelatin.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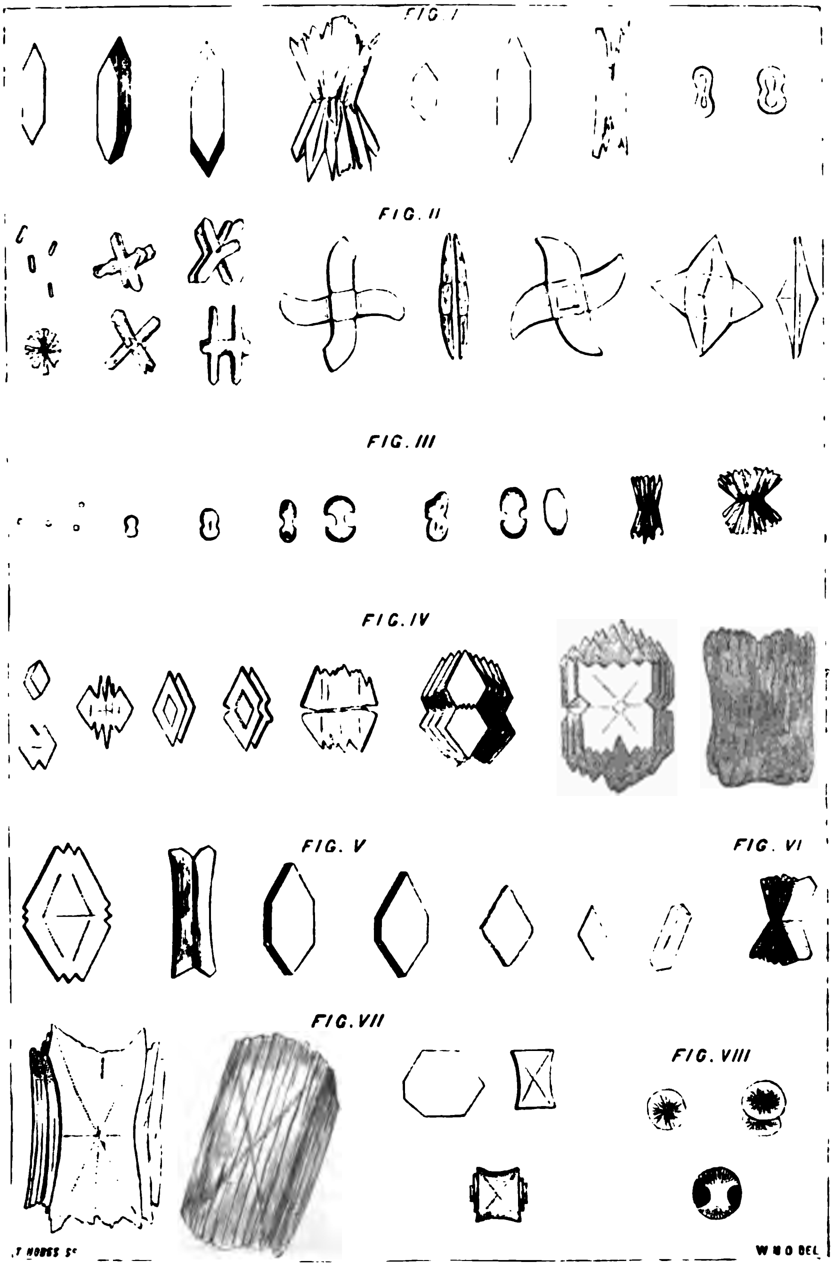
FIG. I
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FIG. V
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FIG. VII
FIG. VIII
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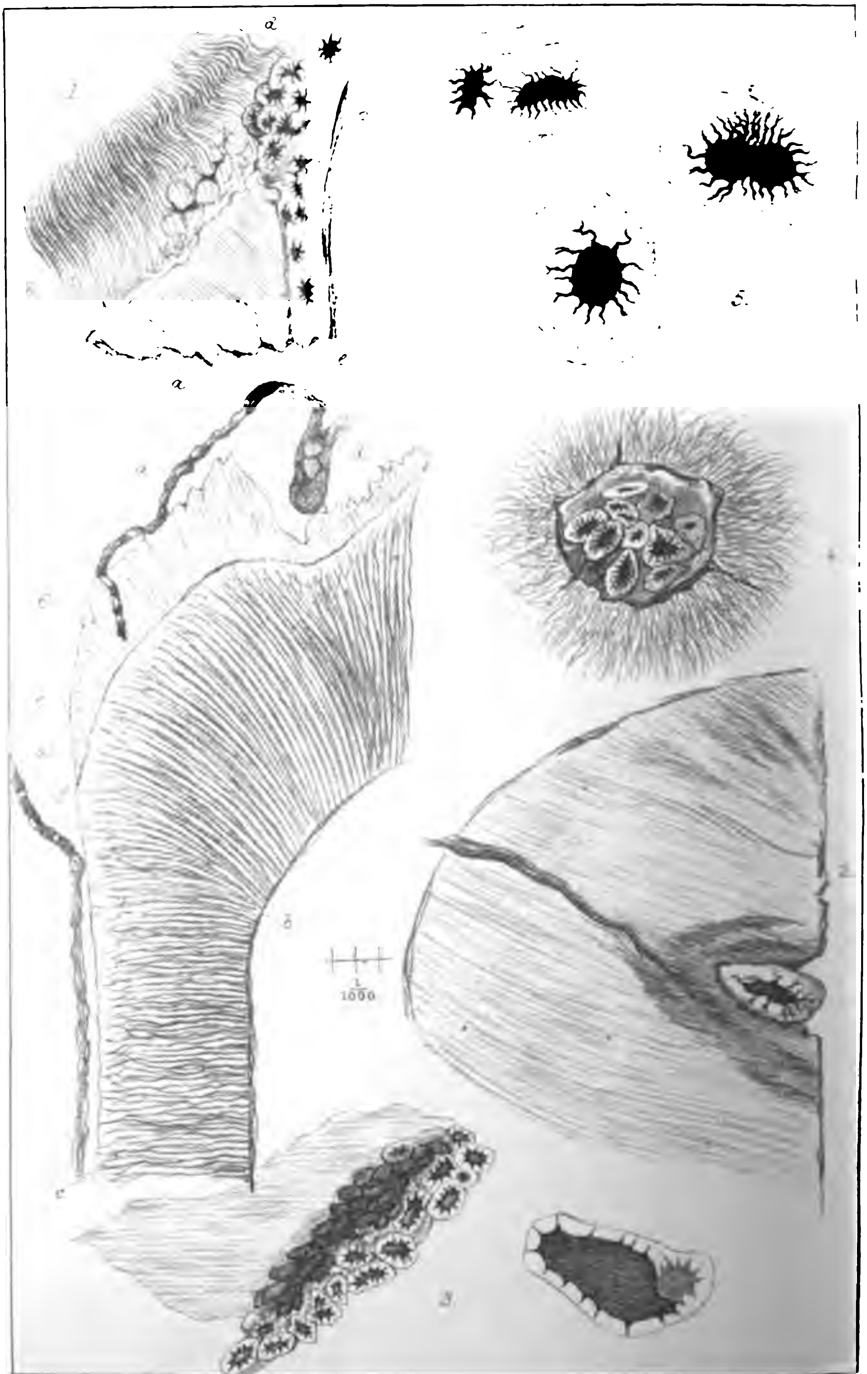

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DESCRIPTION OF PLATE XVII,

Illustrating Mr. Tomes's paper on the Cuticula Dentis.

Fig.

1.—Section of a portion of the crown of a human bicuspid in which the cement is continued over the outside of the enamel. At the point *c* the enamel was altogether absent, its place being taken by cement which was continued over the enamel both above and below this part; at *e* a layer of cement sufficiently thick to contain lacunæ is seen overlying the enamel *a*. At the point *d* the dentinal tubes are seen to be rather irregularly waved and to branch out beneath the cement, thus conclusively proving that the abnomality existed from the time of the first formation of the dentine. × 45 diameters.

a. Enamel. *b*. Dentine. *d*. Dentine. *c*, *e*. Cement.

2.—Portion of enamel from the crown of a human molar tooth, on the outer surface of which there is a depression occupied by a single large lacunal cell. × 125 diameters.

3.—Fragment of enamel from the side of a deep fissure in the masticating surface of a human molar tooth, to which is attached a cluster of lacunal cells. × 60 diameters. To the right is a single lacunal cell more highly magnified.

4.—Transverse section through the enamel of the grinding surface of a human molar tooth. The section passed through three deep fissures with similar contents to the one here figured, which is seen to be filled up by a cluster of lacunal cells. × 60 diameters.

5.—From the thickened cementum of an exostosed human tooth-fang. The lacunæ have the appearance of being enclosed in a capsule of appreciable thickness, but in other places a single line only can be distinguished as surrounding them. × 250 diameters.

6.—Half of the crown and a portion of the root of a bicuspid tooth. The grinding surface was deeply fissured, and previously to treatment with acid the contents of the fissure were too opaque for examination. The section has been treated with dilute acid until a portion of the enamel has been dissolved away, setting free Nasmyth's membrane *a'*, *a*, *d*, which has been but little disturbed from its original position. The mass which occupied the fissure *d* is seen to be a part of Nasmyth's membrane *a*, *a'*, which, having been set free from the surface of the enamel *e*, has been torn in one place. Below the termination *f* of the enamel the lower fragment of the membrane is seen to be continuous with the outermost layer of the cement *c*. The membrane in this section is seen as a riband-like structure, which is folded on itself in one or two places where it is detached from the remnant of the enamel. The width of the riband, as here seen, corresponds to the original thickness of the tooth section, the real thickness of Nasmyth's membrane, when seen edgewise, being very small, except where it fills up a fissure as at *d*.

a, *a'*. Nasmyth's membrane. *d*. Nasmyth's membrane in fissure of enamel. *b*. Dentine. *e*. Enamel. *f*. Point of termination of enamel. *c*. Cement.

DESCRIPTION OF PLATE XVIII,

Illustrating Professor Allman's paper on *Noctiluca*.

Fig.

1.—*Noctiluca miliaris* viewed from the ab-oral side. *a*, The entrance to the atrium; *c*, the superficial ridge; *d*, the flagellum; *h*, the nucleus.

In two of the radiating processes nutritive matter is seen enclosed in extemporaneously formed cysts, and some oil-globules (?) are seen adhering to the surface of the central protoplasm. Magnified about 100 diameters.

2.—The animal viewed in a plane at right angles to fig. 1. *a*, Entrance to atrium; *b*, atrium; *c*, superficial ridge; *d*, flagellum; *e*, mouth leading into gullet; the œsophageal ridge, with its tooth-like process, is seen projecting from the walls of the gullet into its cavity, and the vibratile cilium is seen springing from its floor; *f*, broad process extending from the central protoplasm to the superficial ridge *g*, duplicature of walls; *h*, nucleus.

Oil-globules (?) are seen adhering to the surface of the central mass, and nutritive matter is seen in vacuoles formed extemporaneously in some of the radiating offsets.

3. The animal viewed in a position intermediate between that of fig. 1 and that of fig. 2. *a*, Entrance to atrium; *b*, atrium; *c*, superficial ridge; *d*, flagellum; *f*, broad process extending from central protoplasm to superficial ridge; *g*, duplicature of walls.

In the central protoplasm some diatoms are seen enclosed in a vacuole, and another vacuole also enclosing nutritive matter is seen in one of the protoplasm strings.

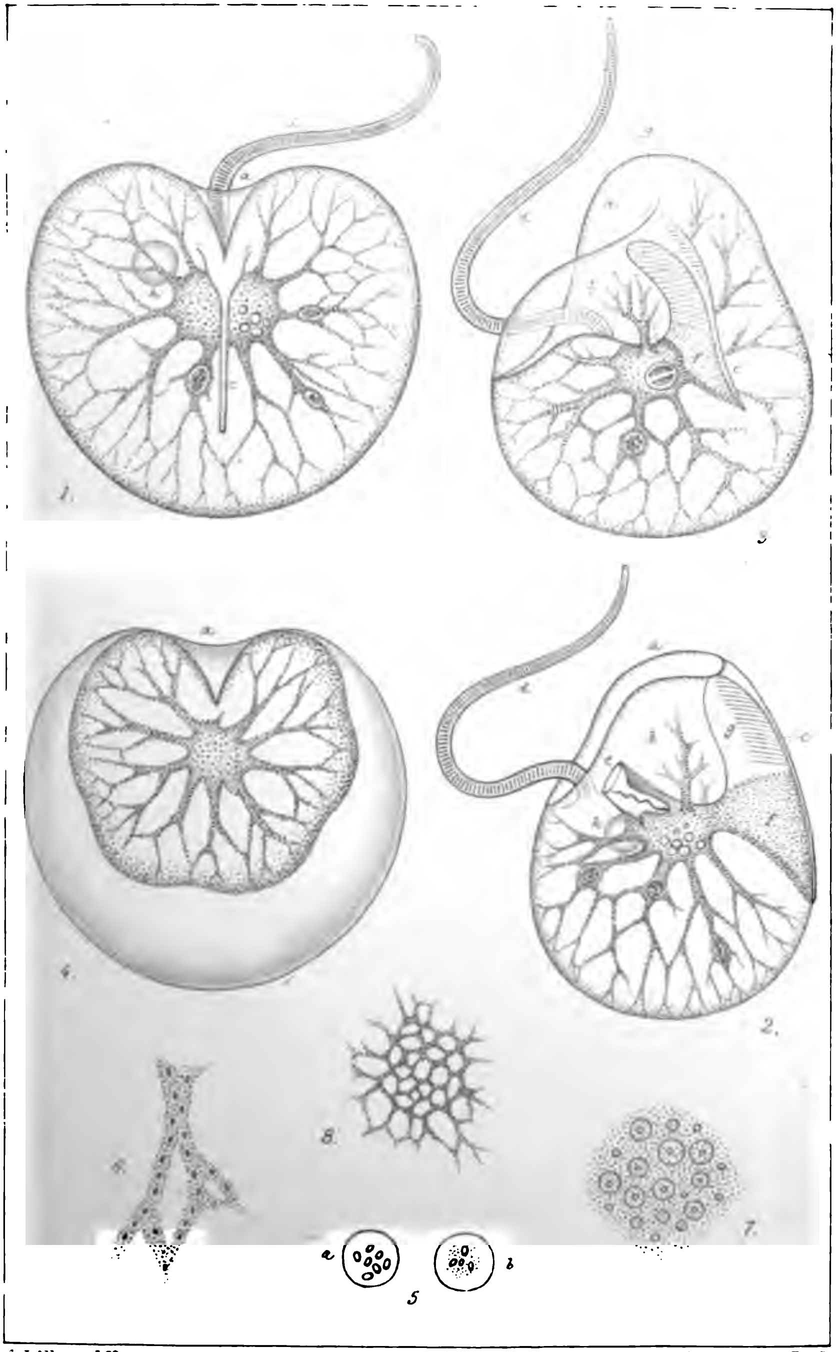
4. The animal acted on by a solution of iodine. The protoplasmic contents have separated from the external structureless wall. *a*, Entrance to the atrium.

5. The nucleus isolated. *a*, Its ordinary appearance under the microscope; *b*, its appearance when acted on by acetic acid.

6. A portion of one of the branching offsets from the central protoplasm.

7. Portion of the peripheral layer, showing cell-like bodies immersed in a finely granular protoplasm.

8. The central protoplasm mass after the discharge of all the solid residue of digestion.



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EXPLANATION OF PLATE XIX,

Illustrating Dr. Hudson's paper on *Pedalion mira.*

Fig.

1.—Dorsal view of female of *Pedalion mira.*

m. The dorsal limb.
n. The right inner limb.
o. The right outer limb.
p. The pseudopodium.
a. The depressor } of the left outer limb.
b. The elevator } of the left outer limb.
d. The depressor } of the left inner limb.
c. The elevator } of the left inner limb.
e. The left pair of muscles of the pseudopodium; the upper the elevator, the lower the depressor.
f, g. Circular muscles surrounding the base of the trochal disc.
h. The left depressor } of the dorsal limb.
k. The left elevator (?) } of the dorsal limb.
l. The antenna of the left outer limb.

2.—Side view of female of *Pedalion mira.*

a—p. As in Fig. 1.
q. Depressor of dorsal antenna.
r. Dorsal antenna.
s. Left depressor of the chin.
t. Extremity of left elevator } of pseudopodium.
u. Extremity of left depressor } of pseudopodium.

3.—Ventral view of female *Pedalion mira.*

e. As in Figs. 1 and 2.
a'. Ventral portion of depressor of left outer limb.
a and *a'* of the left outer limb meet a similar pair of the right outer limb on the mid-dorsal and mid-ventral surfaces, and the four together encircle the whole body; there is another encircling pair of muscles belonging to the dorsal limb, *m*, portions of which are shown at *h*, Figs. 1 and 2.

4.—Dorsal view of male of *Pedalion mira.*

5.—Side view of male of *Pedalion mira.*

6. Mastax flattened by the compressorium.

7. Enlarged view of the dorsal antenna of the female.

N.B.—In the above figures the imbricated plumes of some of the outer limbs, as well as the bristles on some of the inner and dorsal limbs, have been omitted for the sake of clearness.

DESCRIPTION OF PLATE XX,

Illustrating Mr. Ray Lankester's Notes on the Structure of Gregarinæ, and on the Development of *G. Sipunculi*.

Fig. 1.—*Gregarina* (*Monocystis*) *Ascidiæ* observed at Naples; *a*, *a*, spaces in the medullary substance devoid of granules; *m*, fibrillated contractile expansion of the cortical subtance. Length, $\frac{1}{500}$th of an inch.

„ 2.—*Gregarina* (*Monocystis*) *Nereidis*, showing, *m*, the mobile fibrillated enlargement of the cortical substance.

„ 3.—*Gregarina* (*Monocystis*, *Zygocystis*, Stein) *Sipunculi*; a gigantic specimen magnified 25 diameters, found actively swimming in the perivisceral fluid of *Sipunculus nudus* at Naples. The specimen is seen to consist of two individuals united either by apposition or by division of one original individual. Fig. 3 *a*. A similar specimen of the natural size. Fig. 3 *b*. Spherical (encysted) specimens of the natural size. Fig. 3 *c*. Sector of a spherical specimen which is encysted in a sheath of the ciliated peritoneal membrane of the Sipunculus. The characteristic isolated ciliated tufts of this membrane are seen on the surface of the cyst, to which they give a rotatory movement.

„ 4.—Optical section as seen at the margin of the specimen drawn in fig. 3; *a*, tuberculate cuticle; *b*, dense, structureless cortical layer; *c*, granular medullary substance.

„ 5.—Surface view of the tuberculate cuticle of the specimen fig. 3.

„ 6.—*a*, immature pseudo-navicula of *G. Sipunculi*, from a cyst in the perivisceral membrane of *Sipunculus nudus*; *b*, *c*, *d*, *e*, mature pseudo-naviculæ, from a similar cyst. They are provided wth a motionless filament. Length of the pseudo-navicula about $\frac{1}{1000}$th of an inch.

„ 7.—Newly hatched, rapidly moving pseudo-filariæ of *G. Sipunculi*, from cysts in the intestinal wall of *Sipunculus nudus*.

„ 8.—Further advanced, with commencing nucleus.

„ 9.—Commencing transverse division.

„ 10, 11.—The posterior actively moving "tail" is marked off from the immobile, more fully developed "head," forming the pseudo-cercaria.

„ 12, 13.—The separated anterior and posterior segments.

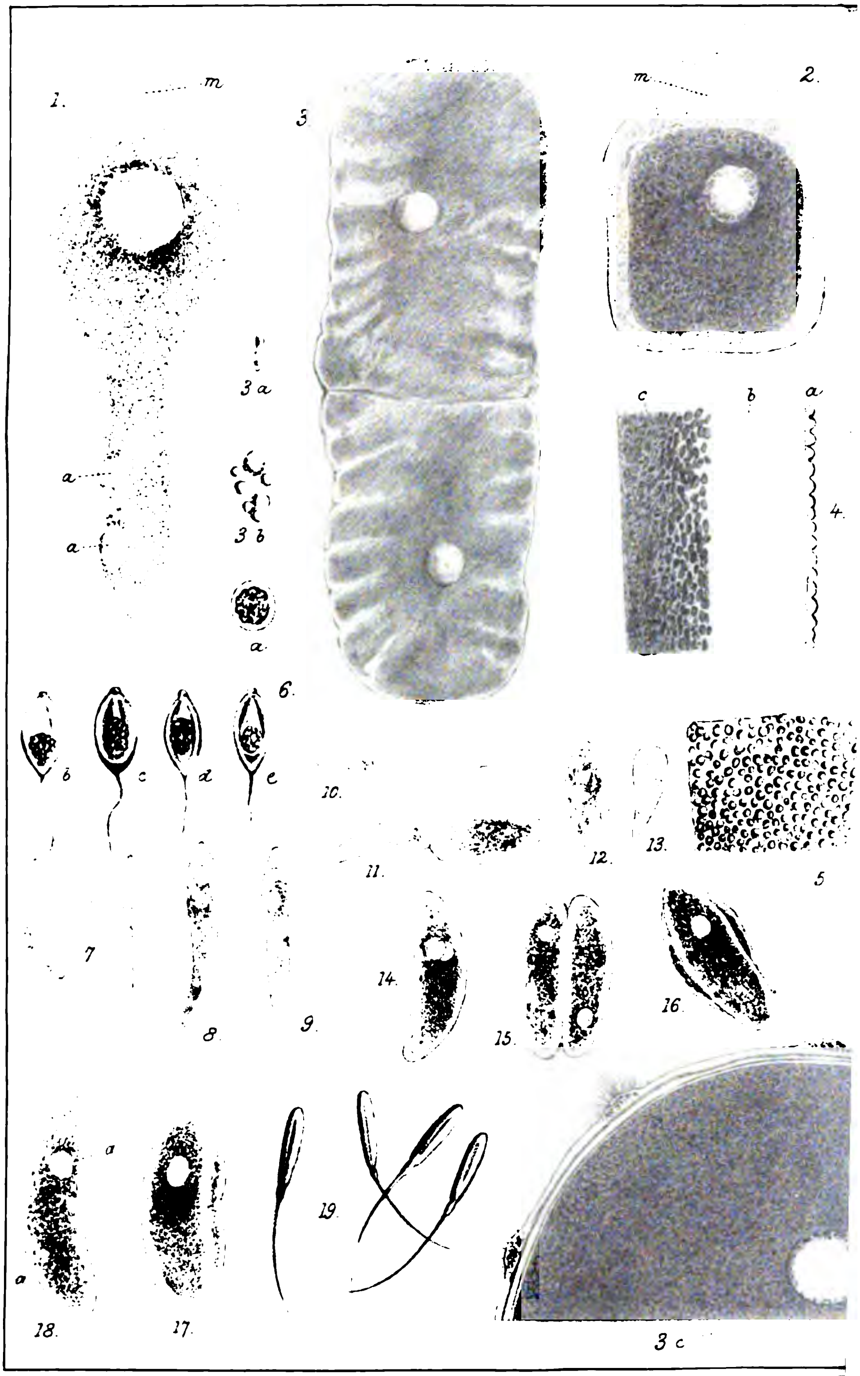
„ 14. Further development of 12 to a true Gregarina form. This specimen presents a double nucleus.

„ 15. Multiplication of the smallest Gregarinæ by longitudinal fission.

„ 16, 17. Stages in that process.

„ 18. A young *Monocystis Sipunculi*, $\frac{1}{800}$th of an inch long.

„ 19. Pseudo-naviculæ of *Gregarina* (*Monocystis*) *Sænuridis* which were observed in prodigious quantities in cysts and liberated in the perivisceral cavity of a specimen of *Tubifex rivulorum*. They possess a motionless filament similar to those of some psorosperms.



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